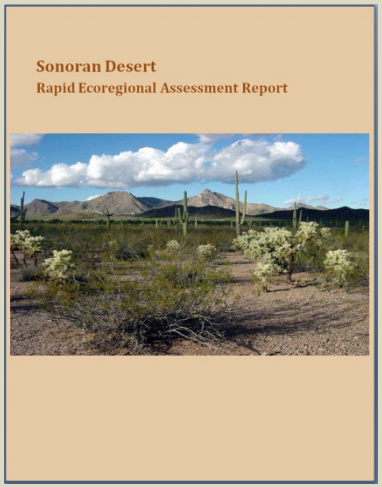
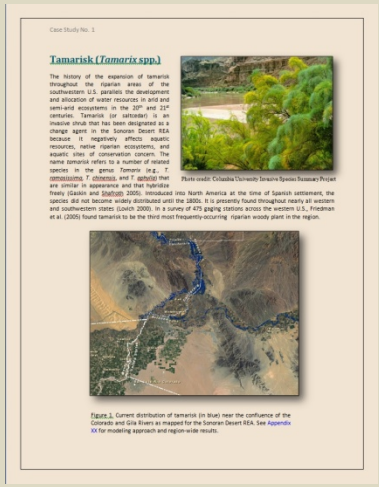
Sonoran Desert
Rapid Ecoregional Assessment Report

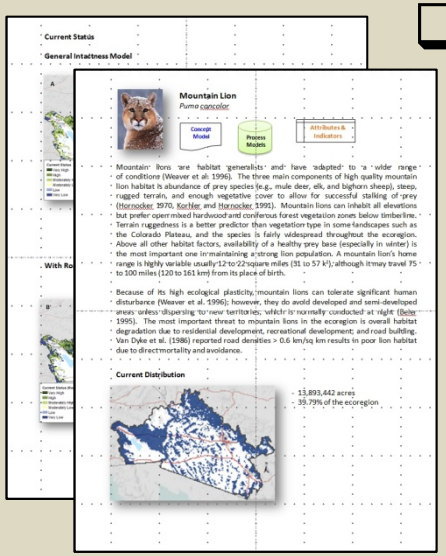
Final Report Organization



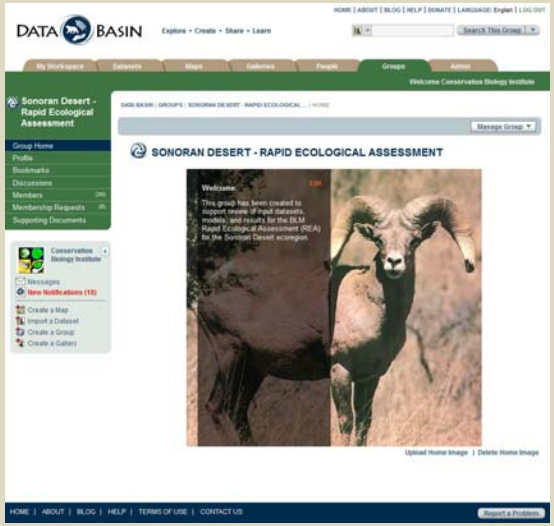
- Main Report



- Inserts



- Appendices



- Electronic Hosting

Inserts

Agassiz's Desert Tortoise (*Gopherus agassizii*) and Morafka's Desert Tortoise (*Gopherus morafkai*)

The desert tortoise was selected as a core conservation element for the Sonoran Desert REA because it is an iconic species of the region that reflects inter-regional variability in climate, landform, and vegetation. The tortoise is a good indicator of desert condition because the two species are widely distributed across the ecoregion and, at the same time, sensitive and vulnerable to multiple disturbance factors. REA results produced maps for current status and future condition of the two populations (now species) of desert tortoise.

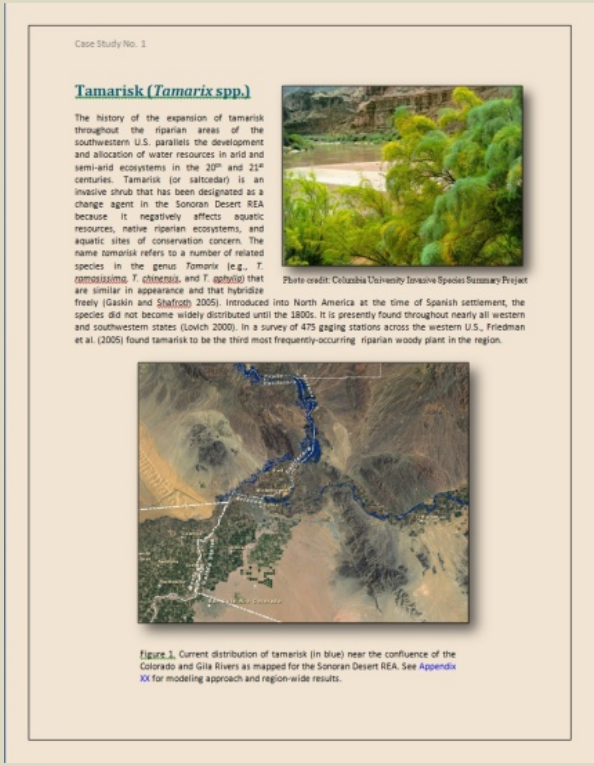
The desert tortoise inhabits desert environments in the Mojave and Sonoran deserts in southern California, southern Nevada, Arizona, southwestern Utah, and northwestern Mexico. Once recognized as a single species (*Gopherus agassizii*) with two recognized populations, it has recently been split into two species. The former Mojave population (Agassiz's desert tortoise) retains the name *Gopherus agassizii*; it occurs north and west of the Colorado River. It was listed as threatened in 1990—22 years after listing, the species is still declining, particularly in the western portion of its range in California (Brussard et al. 1994, Doak et al. 1994, Tracy et al. 2004). The former Sonoran population has been named Morafka's desert tortoise (*Gopherus morafkai*), distinguished from *agassizii* by its different habitat, life history traits, and DNA evidence (USGS 2011). Morafka's desert tortoise occurs east and south of the Colorado River, from Arizona into Mexico.

Agassiz's Desert Tortoise (*Gopherus agassizii*)

Agassiz's desert tortoise occurs mainly in creosote bush (*Larrea tridentata*) flats, but it is also found on sloping terrain on alluvial fans or foothills. It forages mostly on annual plants produced by winter rains. The yearly life cycle of the Agassiz's desert tortoise is heavily influenced by the annual precipitation pattern in the western Sonoran (and Mojave) Desert—precipitation that mainly falls in the winter and early spring with little or no summer precipitation (Van Devender 2006, Dickinson et al. 2006). As a result, most Agassiz's tortoise activity takes place in the spring when winter annuals and spring grasses are readily available (Nagy and Medica 1986, Brussard et al. 1994). The species faces the prospect of annual summer drought; in the hot summer months and throughout the winter, the tortoises spend many months of inactivity in burrows in estivation or hibernation without eating or drinking. In years of low winter rainfall, Agassiz's may feed on introduced annual grasses in the absence or scarcity of winter annuals (Esque 1994), and the species' summer hatchlings may not eat fresh forage until the following spring. While it is known that a diet of invasive grasses will keep tortoises alive, it is unknown if over time such a diet will keep them fit (Esque et al. 2006). Because they are at the northern limit of the their range and because of their dietary restraints and restricted access to water, Agassiz's tortoise may be more vulnerable to mortality from drought, loss of condition, and other stressors than Morafka's tortoise (Peterson 1996, Oftedal 2006).

Photo: Agassiz's desert tortoise, formerly Mojave desert tortoise. K. Nussear, U.S. Geological Survey

Species Conservation Element



Case Study No. 1

Tamarisk (*Tamarix* spp.)

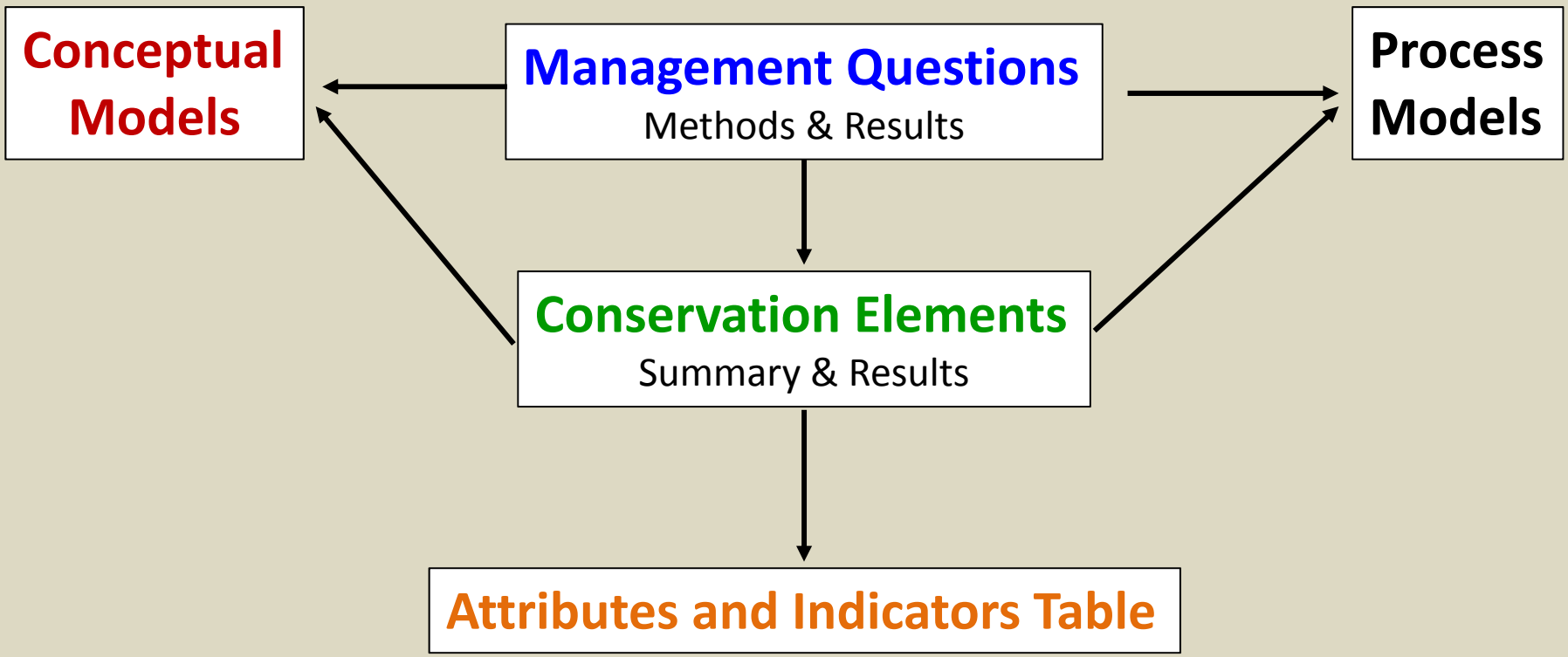
The history of the expansion of tamarisk throughout the riparian areas of the southwestern U.S. parallels the development and allocation of water resources in arid and semi-arid ecosystems in the 20th and 21st centuries. Tamarisk (or saltcedar) is an invasive shrub that has been designated as a change agent in the Sonoran Desert REA because it negatively affects aquatic resources, native riparian ecosystems, and aquatic sites of conservation concern. The name *tamarisk* refers to a number of related species in the genus *Tamarix* (e.g., *T. ramosissima*, *T. chinensis*, and *T. aphylla*) that are similar in appearance and that hybridize freely (Gaskin and Shafroth 2005). Introduced into North America at the time of Spanish settlement, the species did not become widely distributed until the 1800s. It is presently found throughout nearly all western and southwestern states (Lovich 2000). In a survey of 475 gaging stations across the western U.S., Friedman et al. (2005) found tamarisk to be the third most frequently-occurring riparian woody plant in the region.

Photo credit: Columbia University Invasive Species Summary Project

Figure 1. Current distribution of tamarisk (in blue) near the confluence of the Colorado and Gila Rivers as mapped for the Sonoran Desert REA. See Appendix XX for modeling approach and region-wide results.

Change Agent

Appendices


Conceptual Models
Management Questions
Methods & Results
Process Models
Conservation Elements
Summary & Results
Attributes and Indicators Table

Management Questions

A	
SONORAN DESERT	
A. SOILS, BIOLOGICAL CRUSTS, AND FORAGE MANAGEMENT	**Seq**
MQ A1. Where are soils susceptable to wind and water erosion?	
MQ A2. Where are sensitive soils (including saline, sodic, gypsiferous, shallow, low water holding capacity)?	
MQ A3. Which HMAs and allotments may experience significant effects from change agents including climate change?	
B. SURFACE AND GROUNDWATER MANAGEMENT QUESTIONS	
MQ B1. Where are lotic and lentic surface waterbodies and livestock and wildlife watering tanks and artificial water bodies?	
MQ B2. Where are perennial streams and stream reaches?	
MQ B3. Where are the alluvial aquifers and their recharge areas (if known)?	
MQ B4. Where are the aquatic systems listed on 303(d) with degraded water quality or low macroinvertebrate diversity?	
MQ B5. Where are surface water flows likely to increase or decrease in the near-term, 2025 (development), and long-term, 2060 (climate change)?	
MQ B6. What is the location/distribution of these aquatic biodiversity sites?	
MQ B7. What are seasonal discharge maxima and minima for the Colorado River and major tributaries at gaging stations?	
C. ECOLOGICAL SYSTEMS MANAGEMENT QUESTIONS	
MQ C1. Where are existing vegetative communities? - Sonoran Paloverde-Mixed Cacti Desert Scrub (Saguaro)	
MQ C2. Where are vegetative communities vulnerable to change agents in the future? - Sonoran Paloverde-Mixed Cacti Desert Scrub (Saguaro)	
MQ C3. What change agents have affected existing vegetation communities? - Sonoran Paloverde-Mixed Cacti Desert Scrub (Saguaro) - Historic Change	
MQ C3. What change agents have affected existing vegetation communities? - Sonoran Paloverde-Mixed Cacti Desert Scrub (Saguaro) - Recent Disturbances	
MQ C1. Where are existing vegetative communities? - Sonoran-Mojave Creosotebush-White Bursage Desert Scrub (Creosotebush)	
MQ C2. Where are vegetative communities vulnerable to change agents in the future? - Sonoran-Mojave Creosotebush-White Bursage Desert Scrub (Creosotebush)	
MQ C3. What change agents have affected existing vegetation communities? - Sonoran-Mojave Creosotebush-White Bursage Desert Scrub (Creosotebush) - Historic Change	
MQ C3. What change agents have affected existing vegetation communities? - Sonoran-Mojave Creosotebush-White Bursage Desert Scrub (Creosotebush) - Recent Disturbances	
MQ C1. Where are existing vegetative communities? - Sonoran Mid-Elevation Desert Scrub	
MQ C2. Where are vegetative communities vulnerable to change agents in the future? - Sonoran Mid-Elevation Desert Scrub	
MQ C3. What change agents have affected existing vegetation communities? - Sonoran Mid-Elevation Desert Scrub - Historic Change	
MQ C3. What change agents have affected existing vegetation communities? - Sonoran Mid-Elevation Desert Scrub - Recent Disturbances	
MQ C1. Where are existing vegetative communities? - Mogollon Chaparral	
MQ C2. Where are vegetative communities vulnerable to change agents in the future? - Mogollon Chaparral	
MQ C3. What change agents have affected existing vegetation communities? - Mogollon Chaparral - Historic Change	
MQ C3. What change agents have affected existing vegetation communities? - Mogollon Chaparral - Recent Disturbances	
MQ C1. Where are existing vegetative communities? - Apacherian-Chihuahuan Mesquite Upland Scrub	
MQ C2. Where are vegetative communities vulnerable to change agents in the future? - Apacherian-Chihuahuan Mesquite Upland Scrub	
MQ C3. What change agents have affected existing vegetation communities? - Apacherian-Chihuahuan Mesquite Upland Scrub - Historic Change	
MQ C3. What change agents have affected existing vegetation communities? - Apacherian-Chihuahuan Mesquite Upland Scrub - Recent Disturbances	
D. SPECIES CONSERVATION ELEMENT MANAGEMENT QUESTIONS	
MQ D5. What is the location/distribution of terrestrial biodiversity sites? High Biodiversity Sites	
MQ D5. What is the location/distribution of terrestrial biodiversity sites? High Ecological/Cultural Sites	
MQ D5. What is the location/distribution of terrestrial biodiversity sites? National Trails	
MQ D7. Where are HMAs located?	
Mammals	
MQ D1. **Mountain Lion** - What is the most current distribution of available occupied habitat (and historic occupied habitat if available), seasonal and breeding habitat, and movement corridors (as applicable)?	

Management Questions

Soils and forage management questions

MQA1. Where are soils susceptible to wind and water erosion?

Methods ◊ Process Model ◊ Conceptual Model ◊ Results

MQA2. Where are sensitive soils (including saline, sodic, gypsiferous, shallow, low water holding capacity?

Methods ◊ Process Model ◊ Conceptual Model ◊ Results

MQA3. Which HMAs and allotments may experience significant effects from change agents including climate change?

Methods ◊ Process Model ◊ Conceptual Model ◊ Results

Management Questions

Species management questions

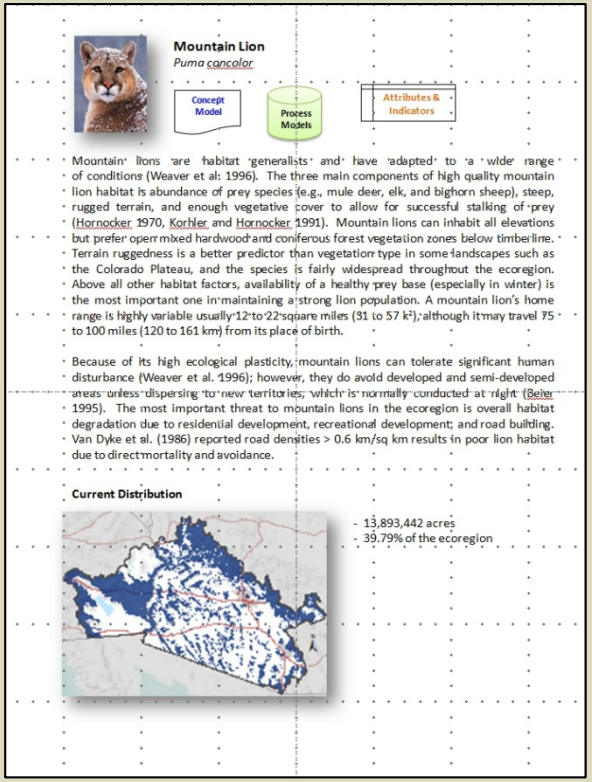
MQD1. What is the most current distribution and status of available occupied habitat?
MQD7. What sites and movement corridors are vulnerable to change in the near term (2015) and long-term (2060) horizon?
MQJ3. Where are areas of species conservation elements potential distribution change from climate change by 2060?

Mountain Lion
Desert Bighorn Sheep
Mule Deer

Bell's Vireo
Golden Eagle
Le Conte's Thrasher
Lucy's Warbler
SW Willow Flycatcher

Lowland Leopard Frog
Desert Tortoise (agassizzi)
Desert Tortoise (morafkai)

Conservation Element



Mountain Lion
Puma cancolor

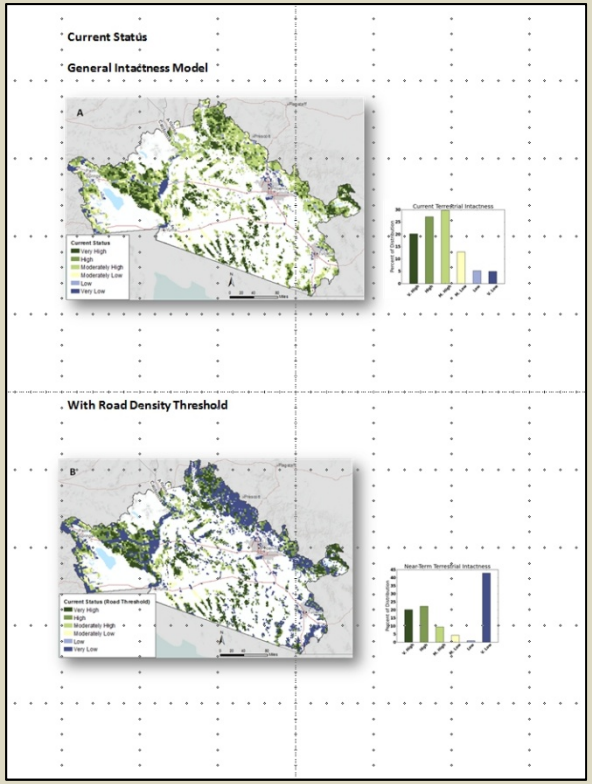
Concept Model | Process Models | Attributes & Indicators

Mountain lions are habitat generalists and have adapted to a wide range of conditions (Weaver et al. 1996). The three main components of high quality mountain lion habitat is abundance of prey species (e.g., mule deer, elk, and bighorn sheep), steep, rugged terrain, and enough vegetative cover to allow for successful stalking of prey (Hornocker 1970, Korhler and Hornocker 1991). Mountain lions can inhabit all elevations but prefer open mixed hardwood and coniferous forest vegetation zones below timberline. Terrain ruggedness is a better predictor than vegetation type in some landscapes such as the Colorado Plateau, and the species is fairly widespread throughout the ecoregion. Above all other habitat factors, availability of a healthy prey base (especially in winter) is the most important one in maintaining a strong lion population. A mountain lion's home range is highly variable usually 12 to 22 square miles (31 to 57 k^2), although it may travel 75 to 100 miles (120 to 161 km) from its place of birth.

Because of its high ecological plasticity, mountain lions can tolerate significant human disturbance (Weaver et al. 1996); however, they do avoid developed and semi-developed areas unless dispersing to new territories, which is normally conducted at night (Beier 1995). The most important threat to mountain lions in the ecoregion is overall habitat degradation due to residential development, recreational development; and road building. Van Dyke et al. (1986) reported road densities > 0.6 km/sq km results in poor lion habitat due to direct mortality and avoidance.

Current Distribution

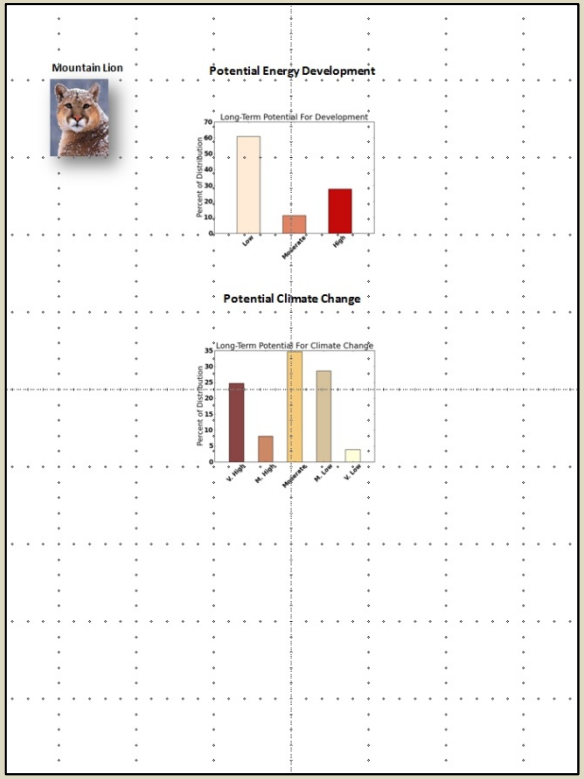
- 13,893,442 acres
- 39.79% of the ecoregion



Current Status

General Intactness Model

With Road Density Threshold



Mountain Lion

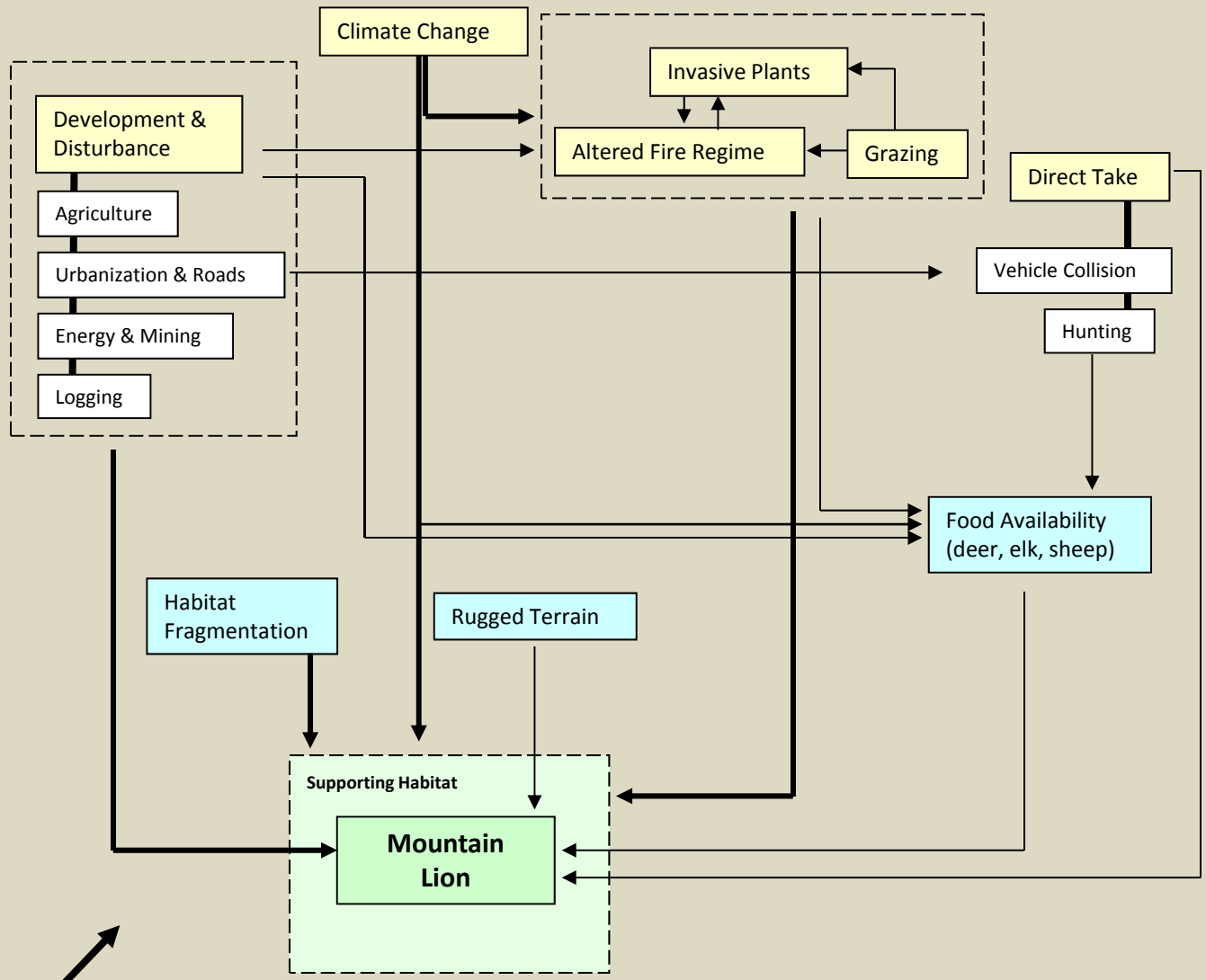
Potential Energy Development

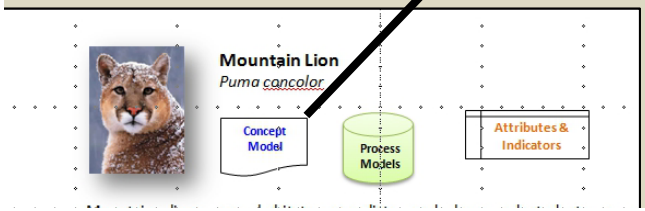
Long-Term Potential For Development

Potential Climate Change

Long-Term Potential For Climate Change

Conceptual Model





Process Model

SOD – Mountain Lion Process Model

MQ D1: Mountain Lion Current Distribution and Status

All files clipped with boundary file called Outline of 5th-level HUC (10-digit) watersheds, Sonoran Desert ecoregion

Distribution

Mountain Lion Distribution in California in the Sonoran Desert Ecoregion. (CA GAP Program) —Extract, HAB-CODE = 1,2→

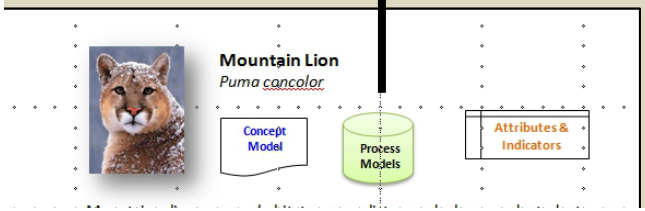
Mountain Lion Distribution in Arizona in the Sonoran Desert Ecoregion. (AZ GAP Program) —Extract, GRID-CODE = 2→

Results: Mountain Lion Distribution in the Sonoran Desert Ecoregion, USA

4km Results: Current Terrestrial Landscape Intactness

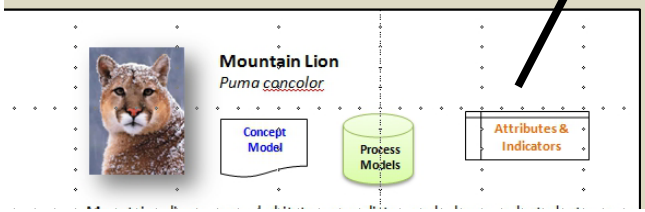
Status

—Intersect→ Current Mountain Lion Status



Attributes and Indicators – Mountain Lion

Element	Attribute	Indicator	Poor	Fair	Good	V. Good	Citation
Mountain Lion	Prey	Ungulate density	Low	Medium	High	Very high	Julander and Jeffrey (1964)
	Habitat degradation	Road density	0.6 km/sq km	0.4	0.2	0.0	Van Dyke et al. (1986)
	Habitat	Cover & terrain	Very dense or open cover			Rugged terrain with mixed cover	Riley (1998)
	Habitat degradation	Human development	High	Moderate	Low	No	Van Dyke et al. (1986)



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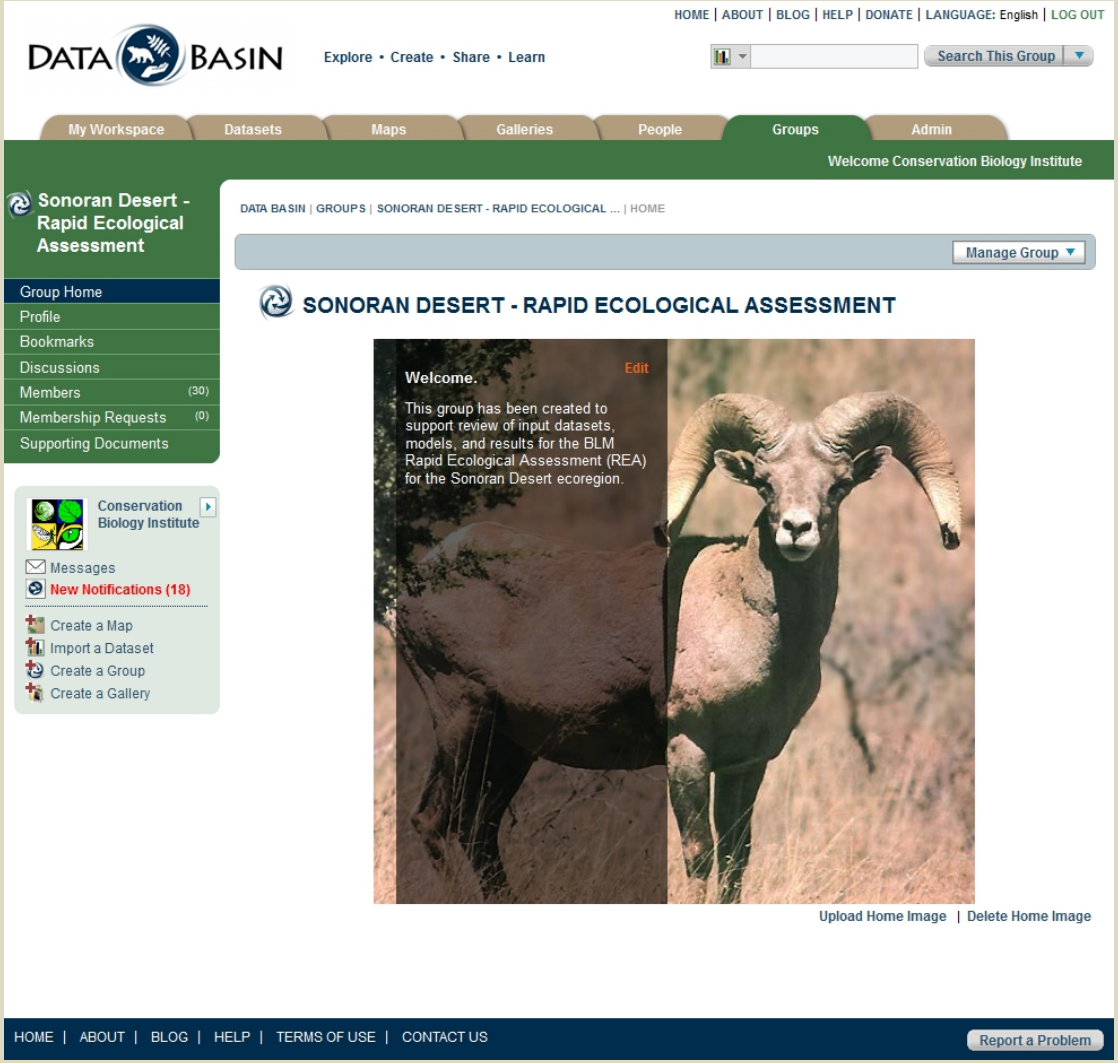

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    - CE - Soils
      - Additional Soils
      - MQA1 - Wind and Water Erosio
      - MQA2 - Sensitive Soils
      - MQA3 - Change to HMAs and A
    - Ecological Systems
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Add Items

Sort By: Creation Date (newest to oldest)

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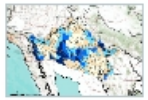
Showing 1 - 10 of 20 items

SOD MQA2 - Soil Sensitivity *[private]*



Credits: Conservation Biology Institute

Results for soil sensitivity for the Sonoran Desert ecoregion.

13 datasets | 1 comment | Created Jul 8, 2011 b Conservation Biology Institut

view details
open live map
[+] more

HUC Results: Highly sensitive soils - Sonoran Desert ecoregion USA *[private]*

Credits: Wendy Peterman, Conservation Biology Institute

This dataset shows the percent of each 5th-level HUC (10-digit) watershed with highly sensitive soils . This means one or more of the following is true: the NRCS wind erodibility group is 1 or 2, Available Water Capacity is <0.05 in the top ...

Layer Package

(Page 1 of 2)

First | Previous | 1 | 2 | Next | Last

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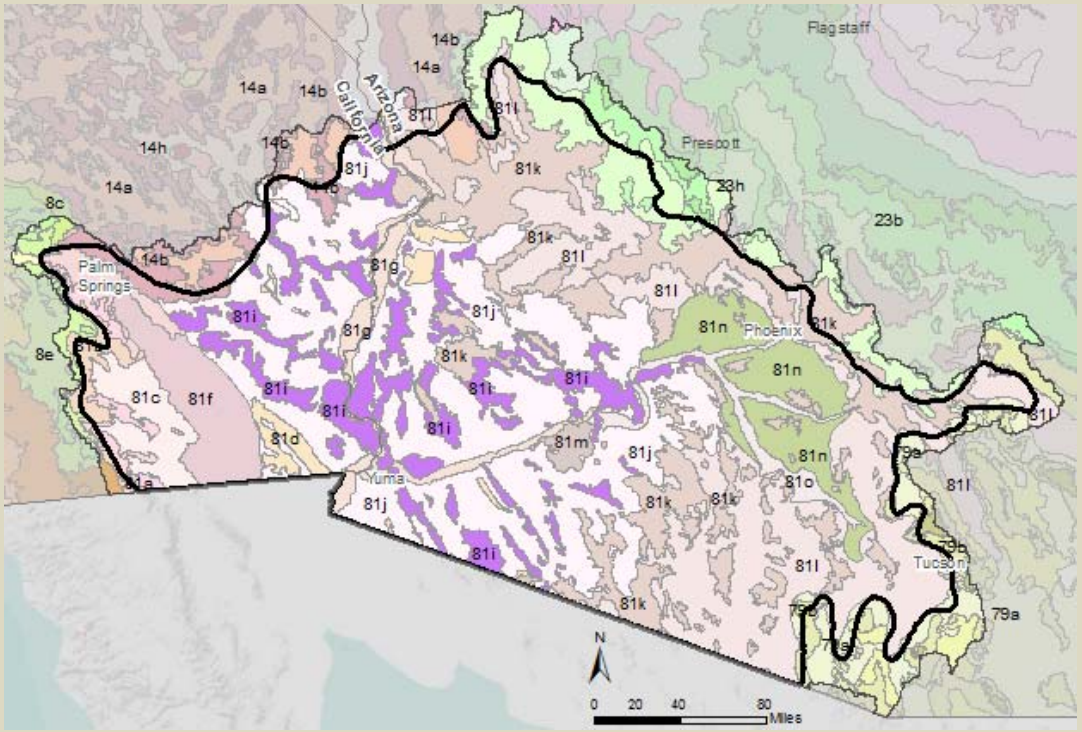
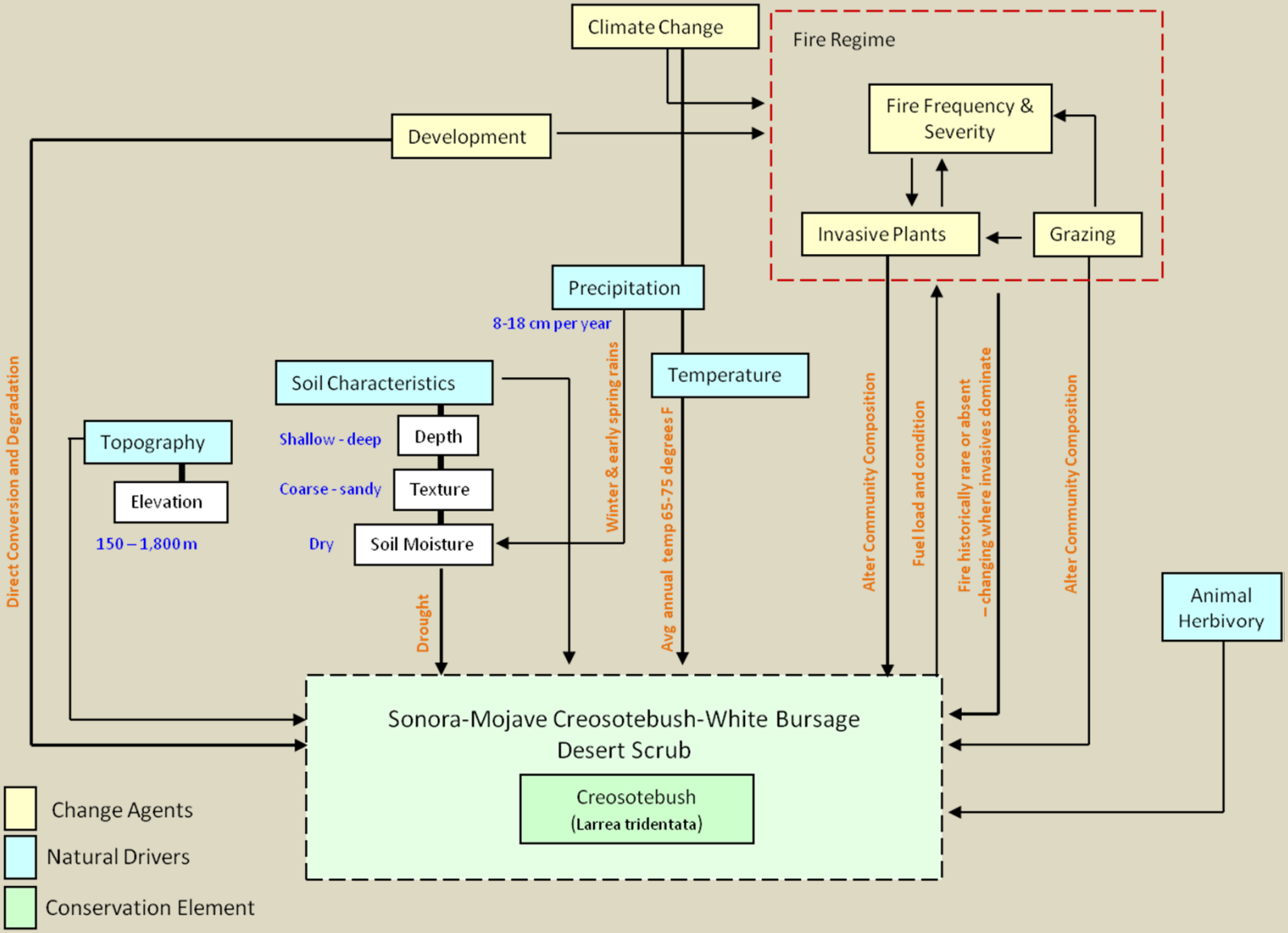
Report a Problem

Methods

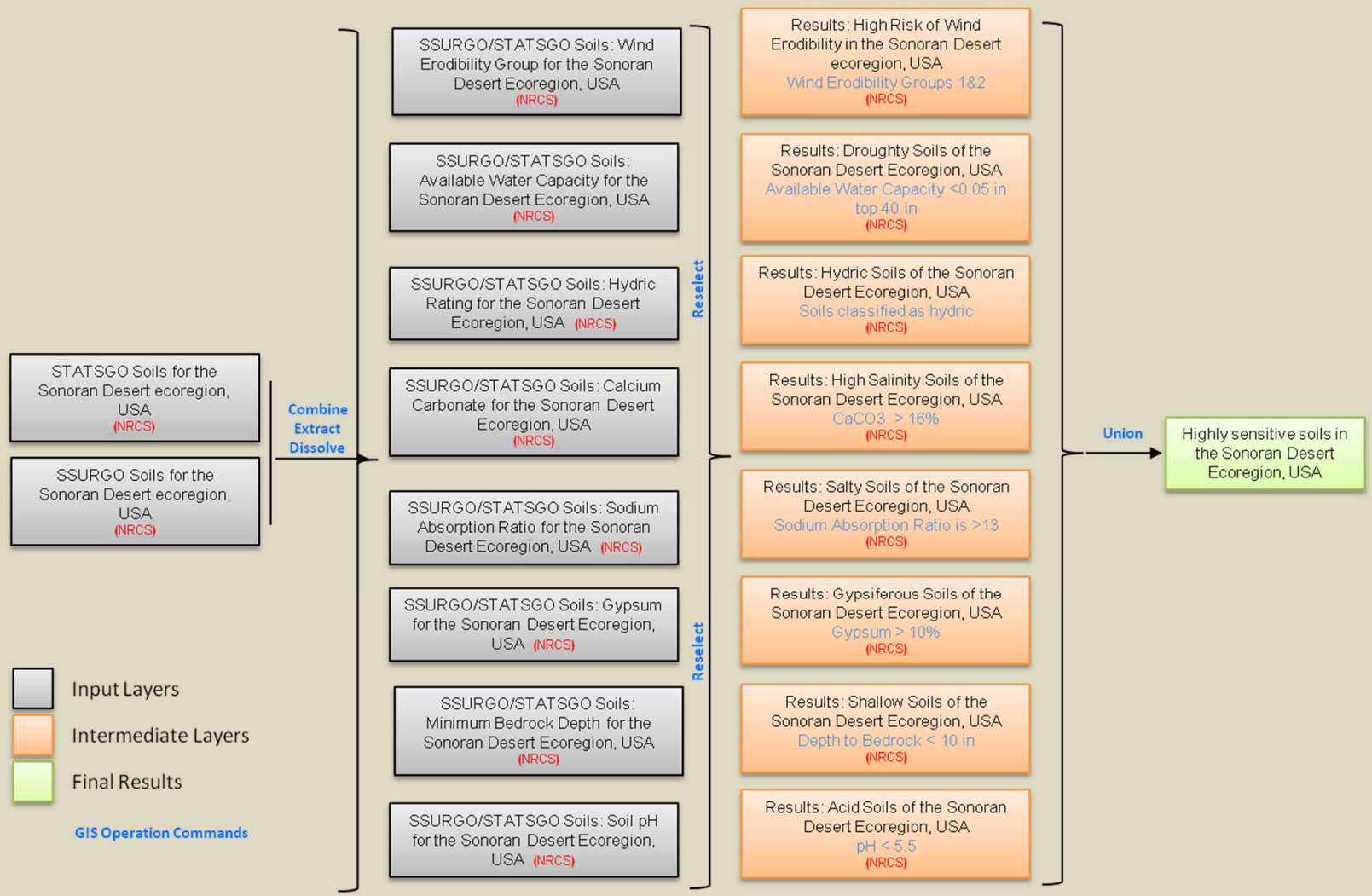


- Conceptual Models
- Process Models
- Logic Models
- FRAGSTATS
- Connectivity Modeling
- Climate Modeling

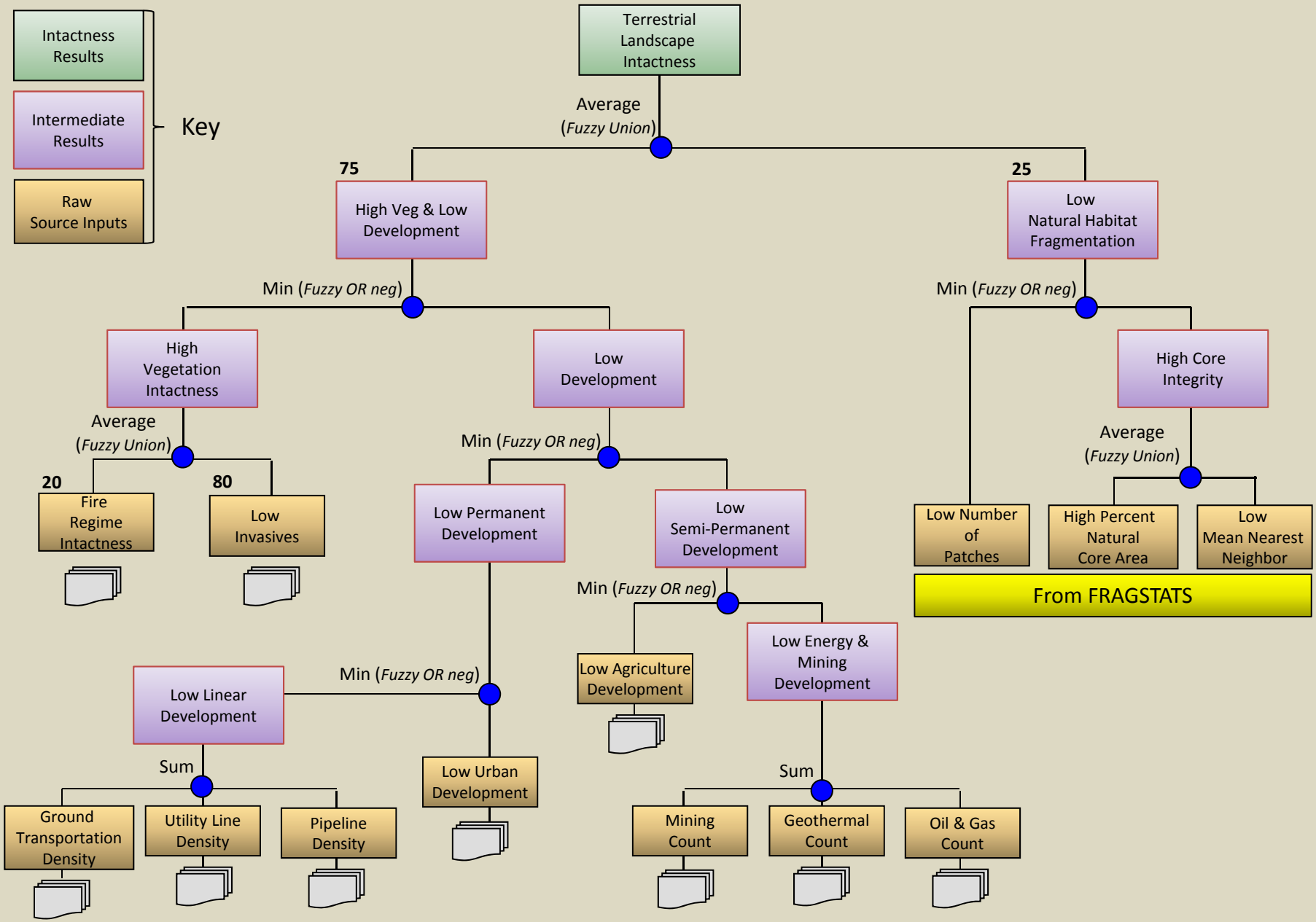
Conceptual Models



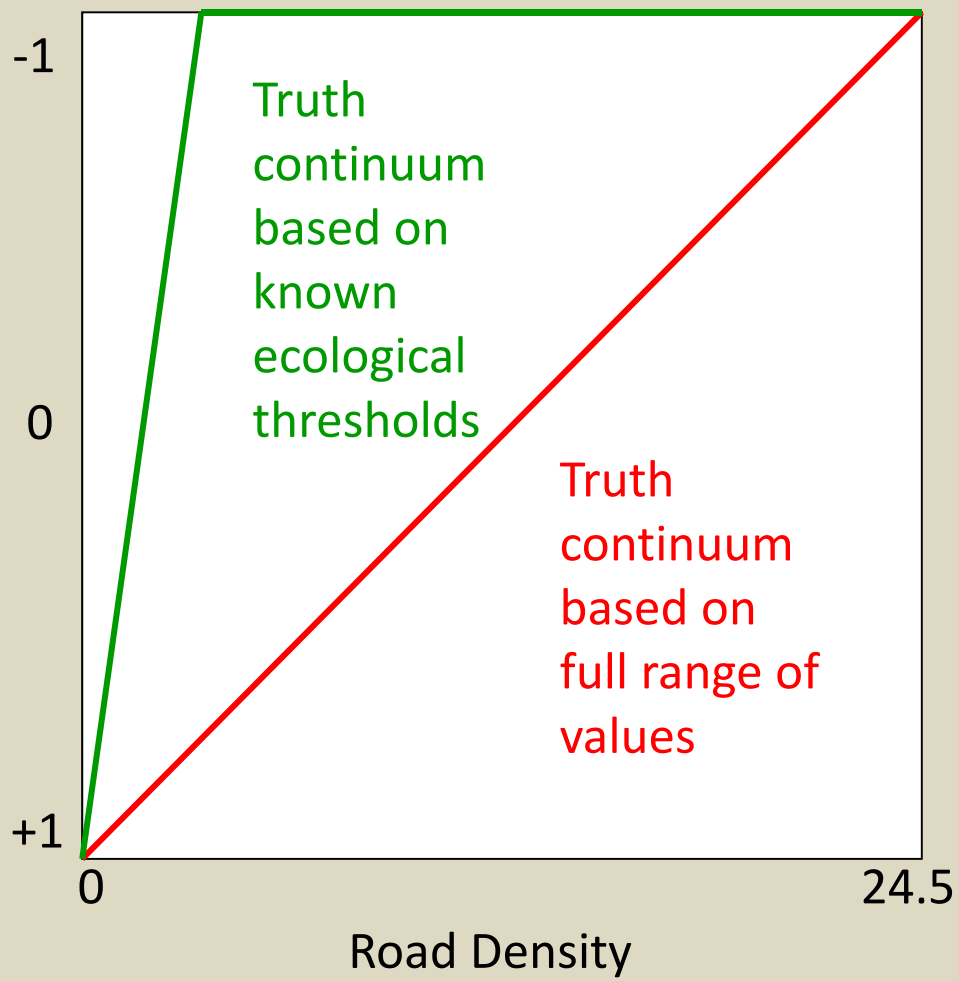
Process Models



Logic Models



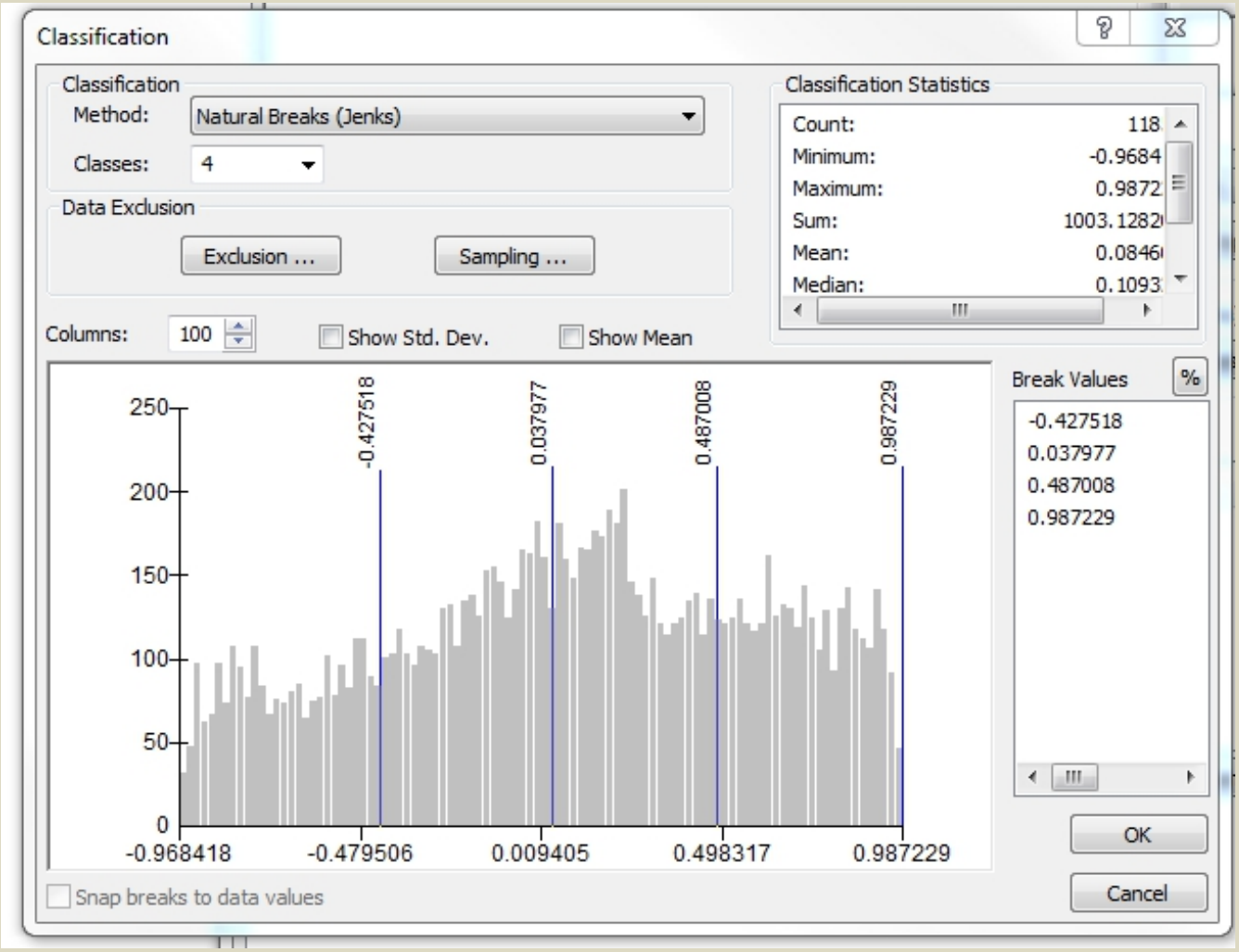
Fuzzy Logic


-1
0
+1
0
24.5
Road Density
Truth continuum based on known ecological thresholds
Truth continuum based on full range of values

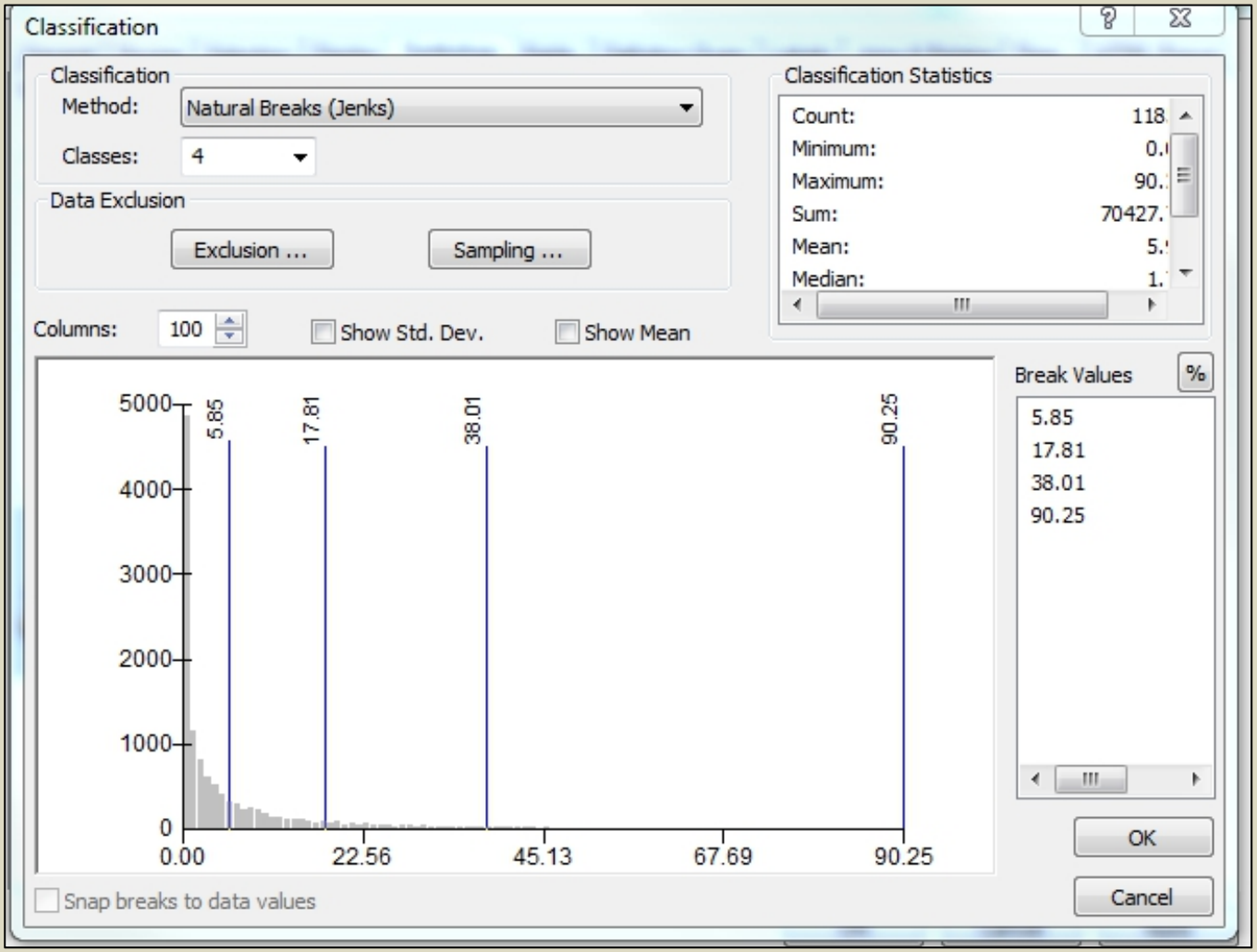
Thresholds for Terrestrial Landscape Intactness

Item	Data Type	Data Range	True Threshold	False Threshold
Fire Regime	Percent Area	0-100	7	100
Invasive Grasses & Tamarisk	Percent Area	0-88	0	33
Linear Development	Density	0-18	0	2.5
Urban Percent	Percent Area	0-99	0	15
Agriculture Percent	Percent Area	0-90	0	20
Energy & Mining Development	Number	0-37	0	1.25
Number of Patches	Number	1-1,455	0	850
Mean Nearest Neighbor	Distance	60-272	59	180
Percent Natural Core Area	Percent Area	.56-95	100	20

Thresholds for Terrestrial Landscape Intactness



Thresholds for Terrestrial Landscape Intactness

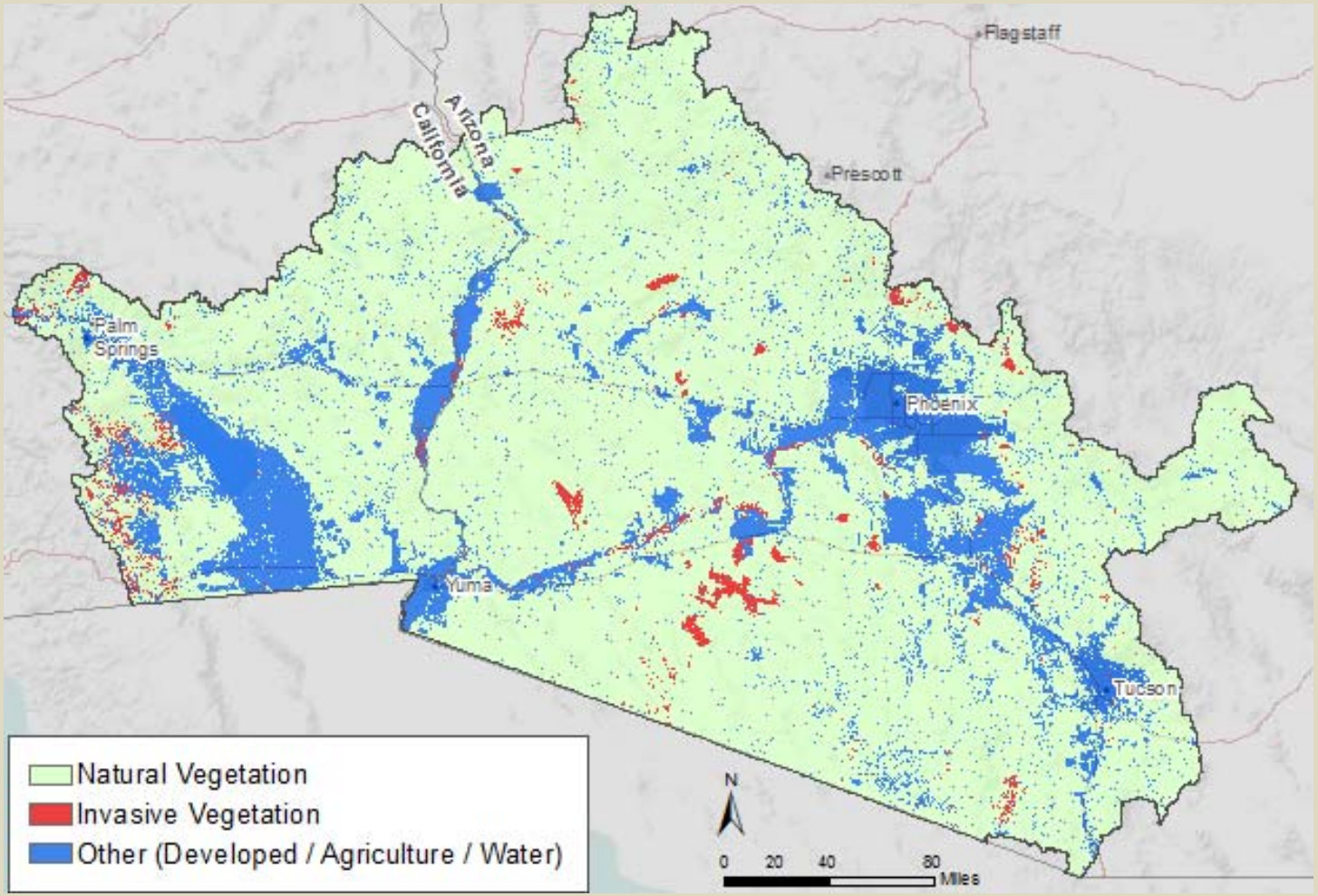


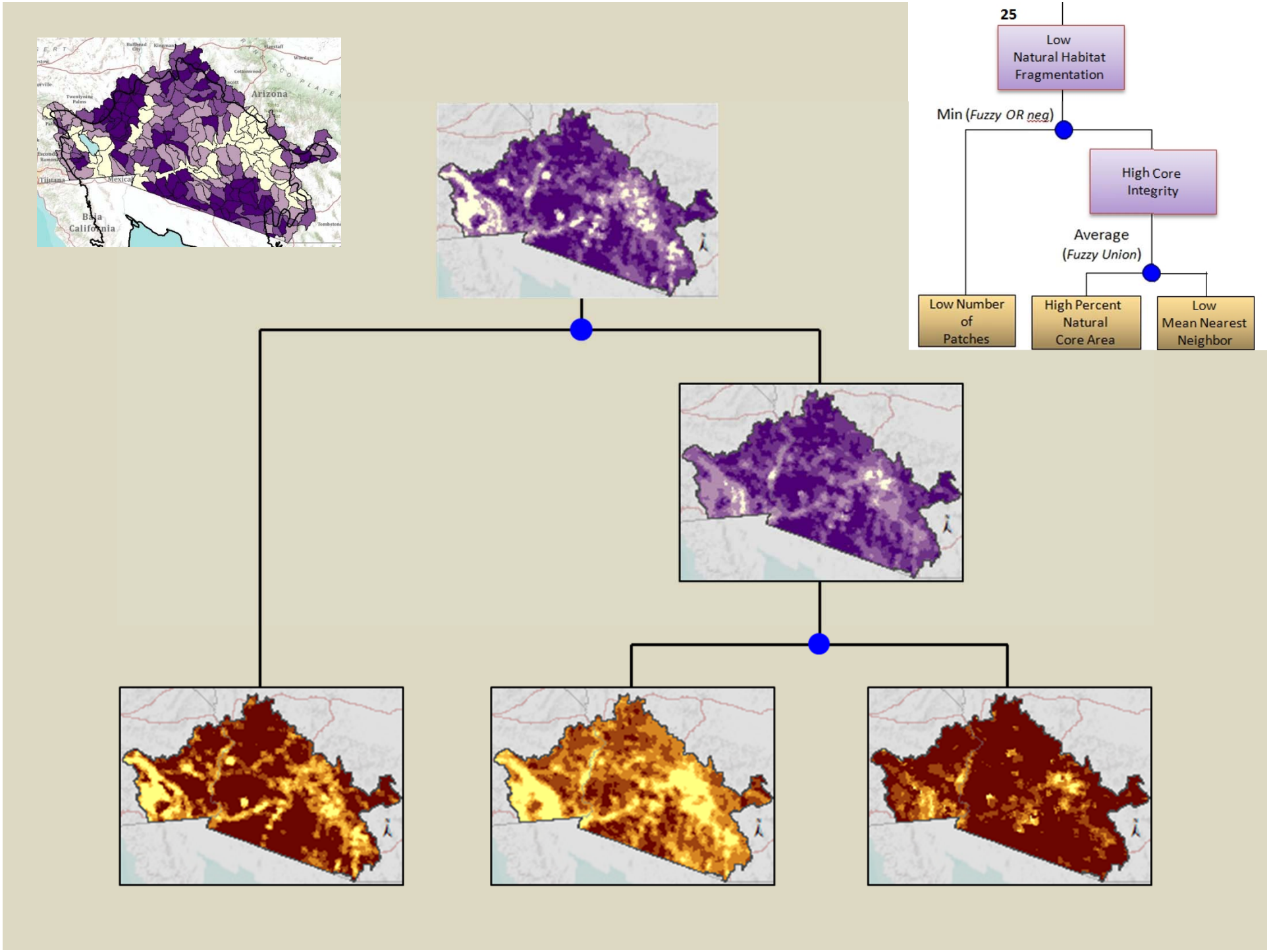
Terrestrial Landscape Intactness Value Ranges

Intactness Value	Legend
-1.000 to -0.750	Very Low
-0.750 to -0.500	Low
-0.500 to 0.000	Moderately Low
0.000 to 0.500	Moderately High
0.500 to 0.750	High
0.750 to 1.000	Very High

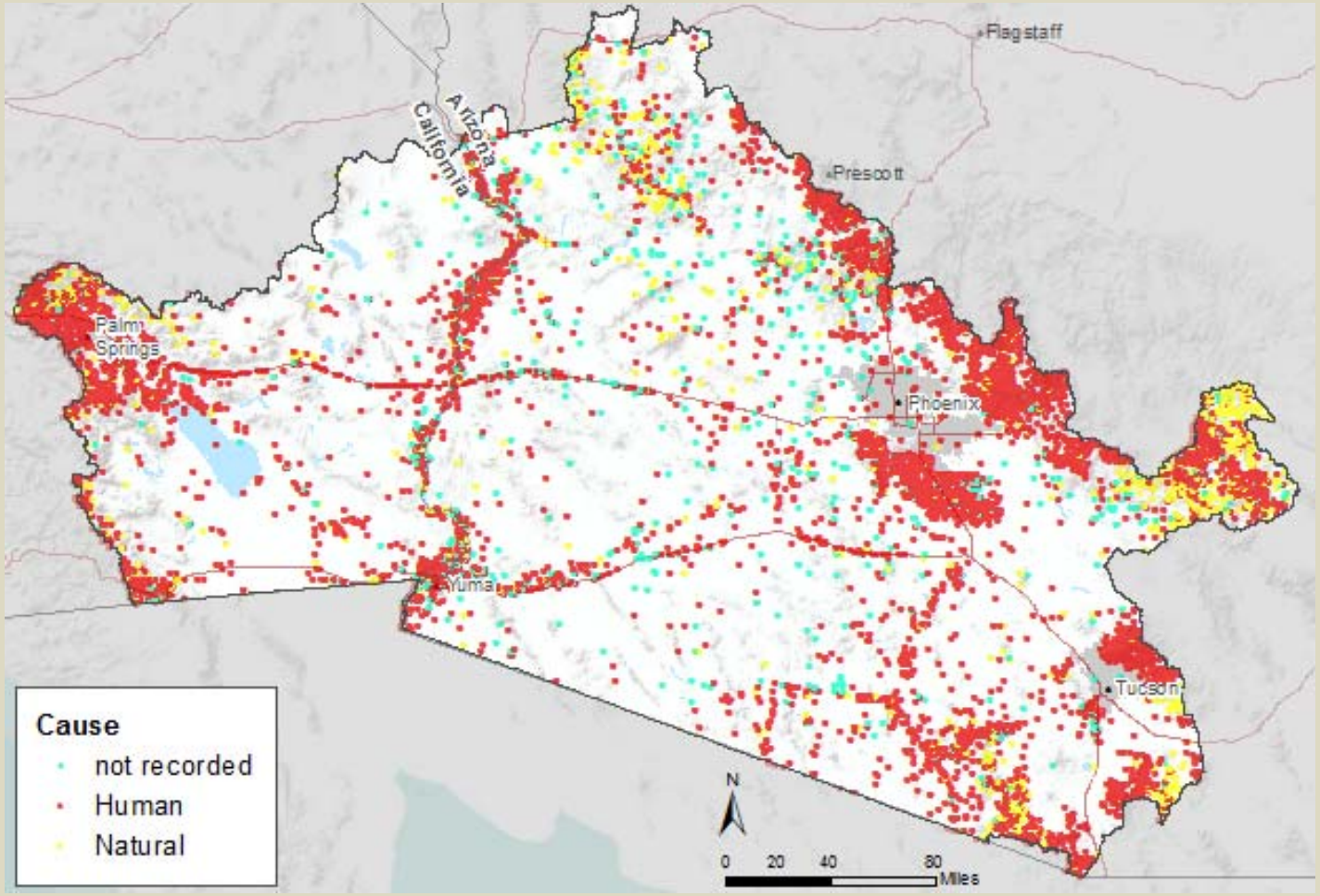
Habitat Fragmentation - FRAGSTATS

4km and HUC

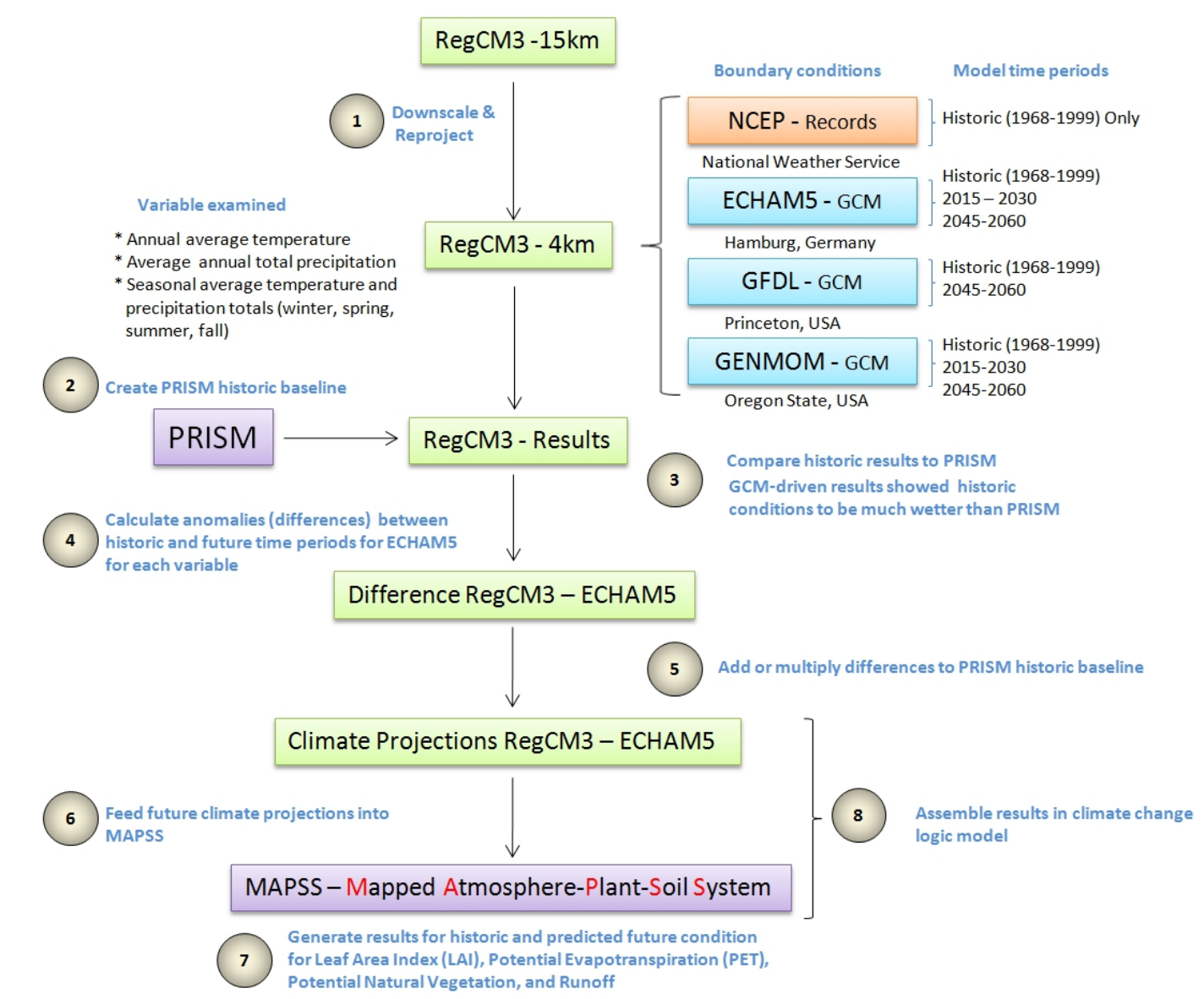



25
Low Natural Habitat Fragmentation
Min (Fuzzy OR neg)
High Core Integrity
Average (Fuzzy Union)
Low Number of Patches
High Percent Natural Core Area
Low Mean Nearest Neighbor
Arizona
Baja California

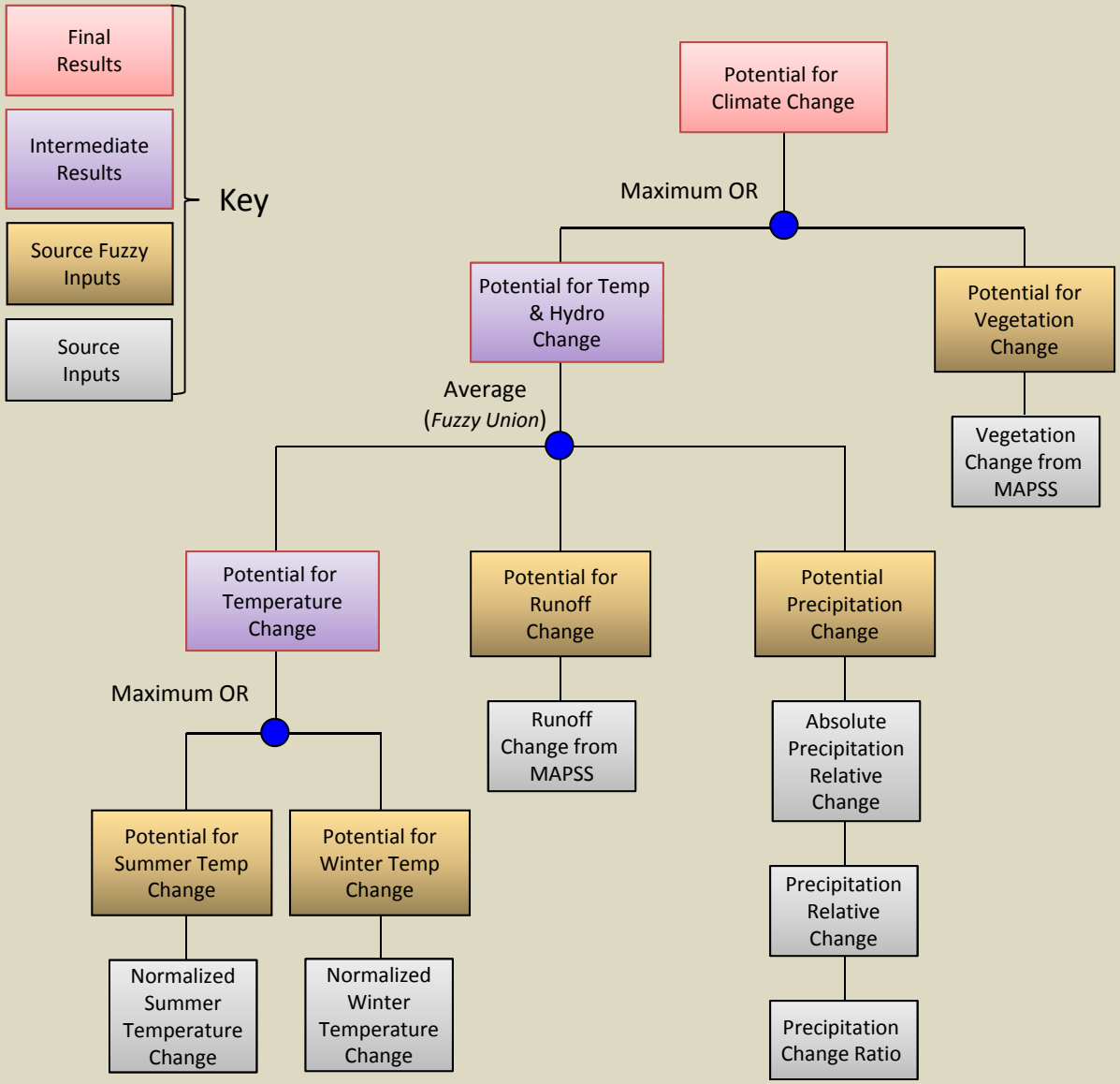
Fire Modeling

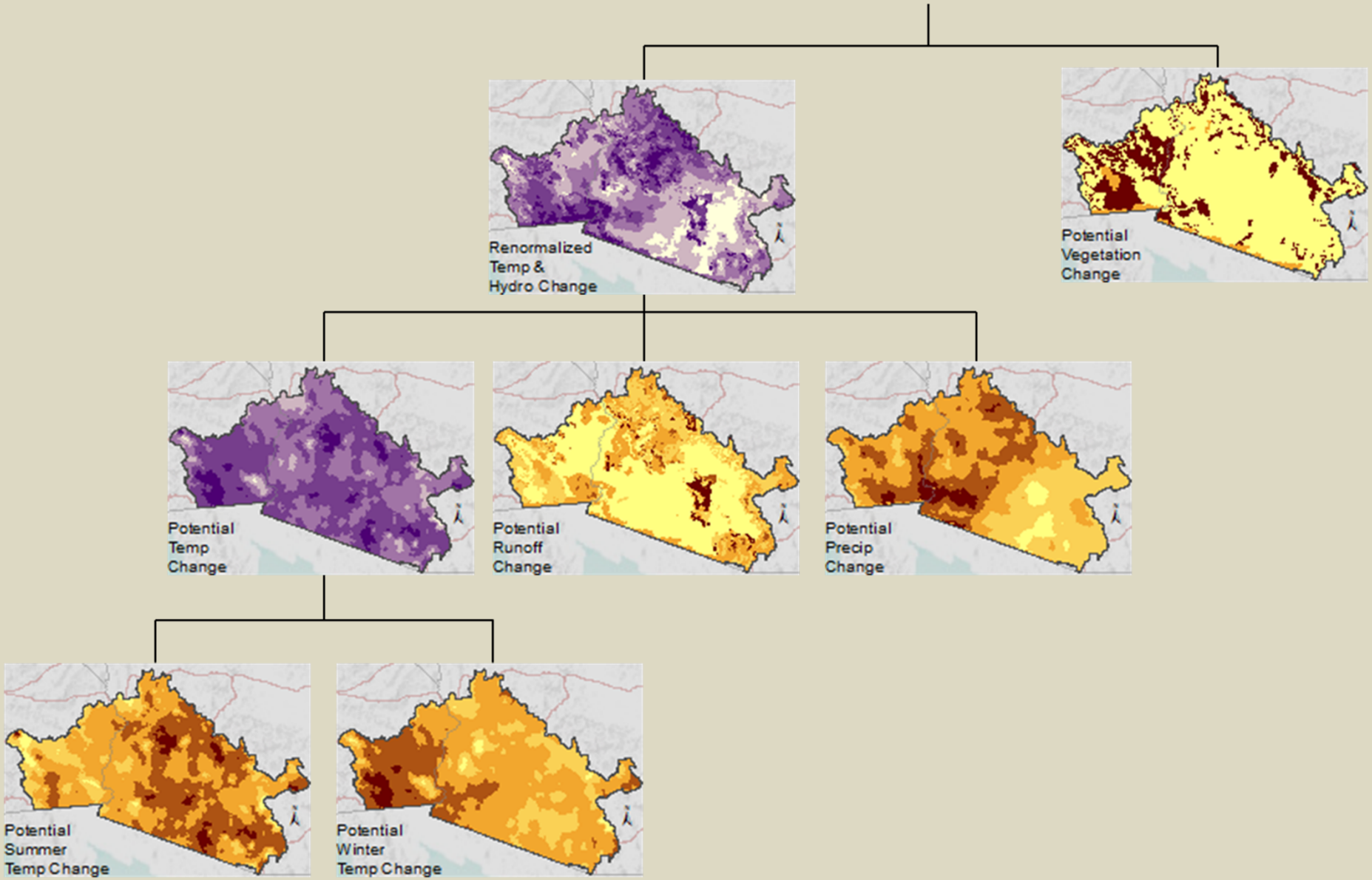


Climate Change Modeling



Climate Change Modeling

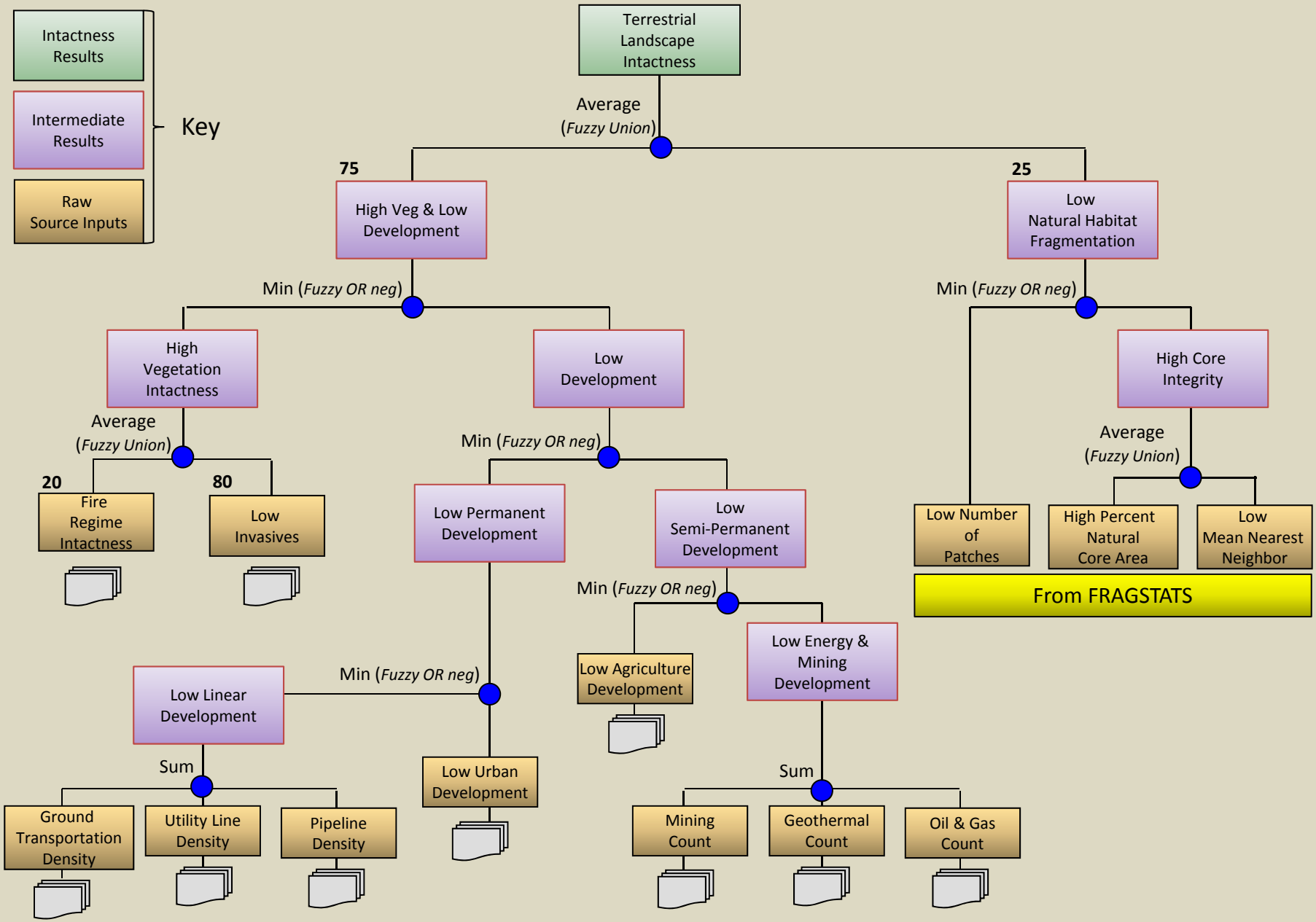



Renormalized
Temp &
Hydro Change
Potential
Vegetation
Change
Potential
Temp
Change
Potential
Runoff
Change
Potential
Precip
Change
Potential
Summer
Temp Change
Potential
Winter
Temp Change

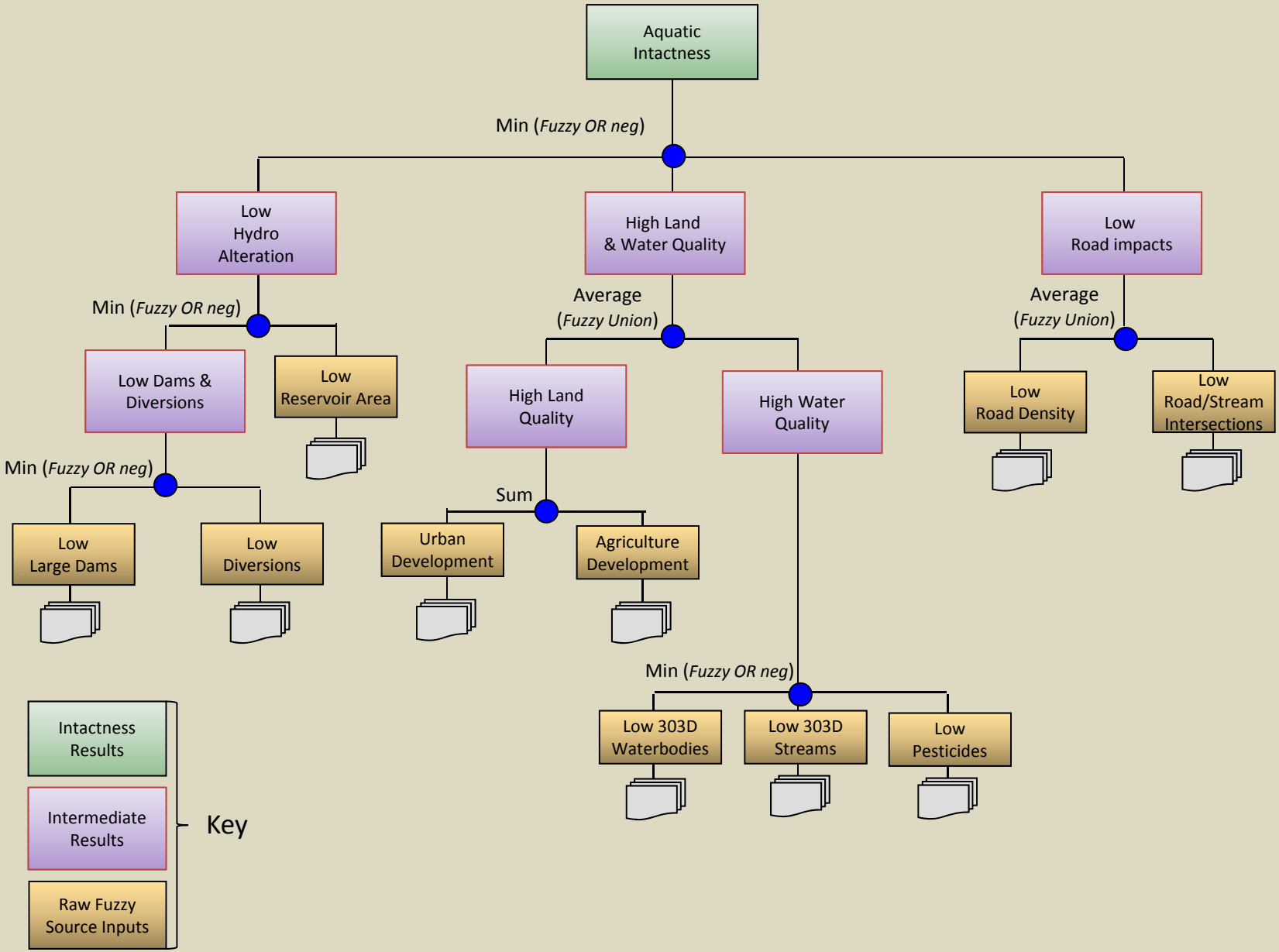
Distribution and Status

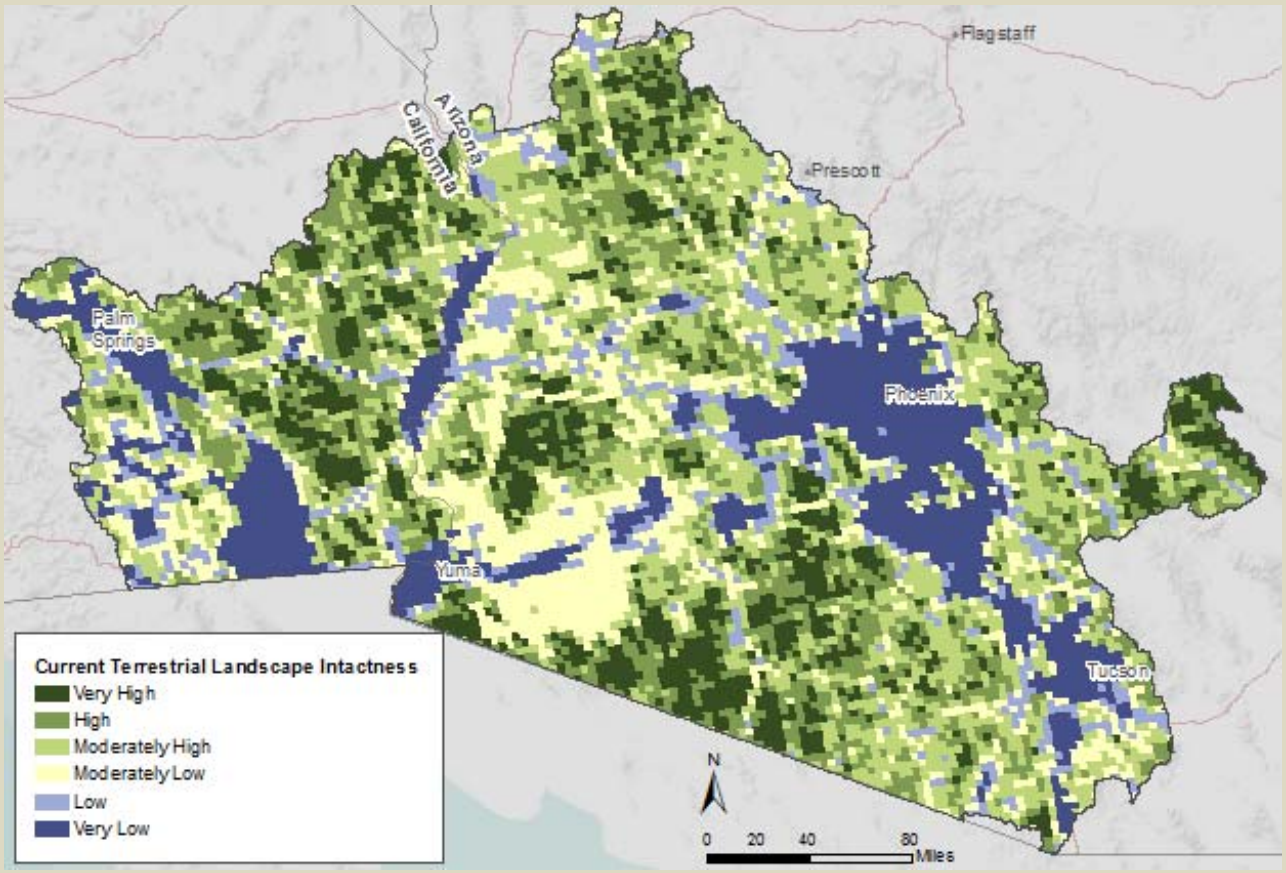
Species CEs	Total Distribution Area	Percent of Ecoregion
Bell's Vireo (*Vireo bellii and Vireo bellii* pusillus)	2,821,371	**8.08%**
Desert Bighorn Sheep (*Ovis canadensis nelsoni*)	7,862,801	**22.52%**
Desert tortoise (*Gopherus agassizii*)	3,180,566	**9.11%**
Desert tortoise (*Gopherus morafkai*)	6,950,996	**19.91%**
Golden Eagle (*Aquila chrysaetos*)	17,257,325	**49.42%**
Le Conte's Thrasher (*Toxostoma lecontei*)	9,771,582	**27.99%**
Lowland Leopard Frog (*Lithobates yavapaiensis*)	678,014	**1.2%**
Lucy's Warbler (*Oreothlypis luciae*)	13,753,047	**39.39%**
Mountain Lion (*Puma concolor*)	13,893,442	**39.79%**
Mule Deer (*Odocoileus hemionus*)	26,845,687	**76.89%**
SW Willow Flycatcher (*Empidonax traillii extimus*)	139,328	**0.40%**

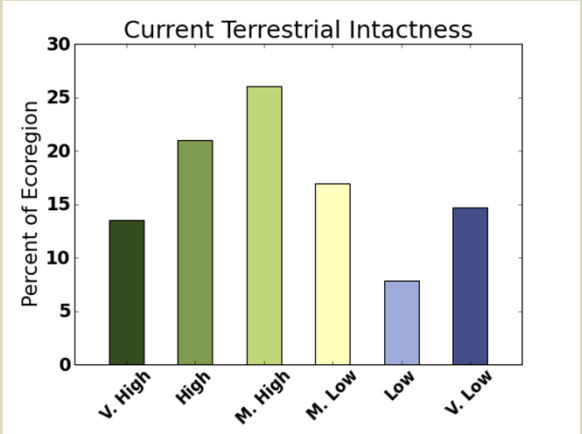
Current Terrestrial Intactness

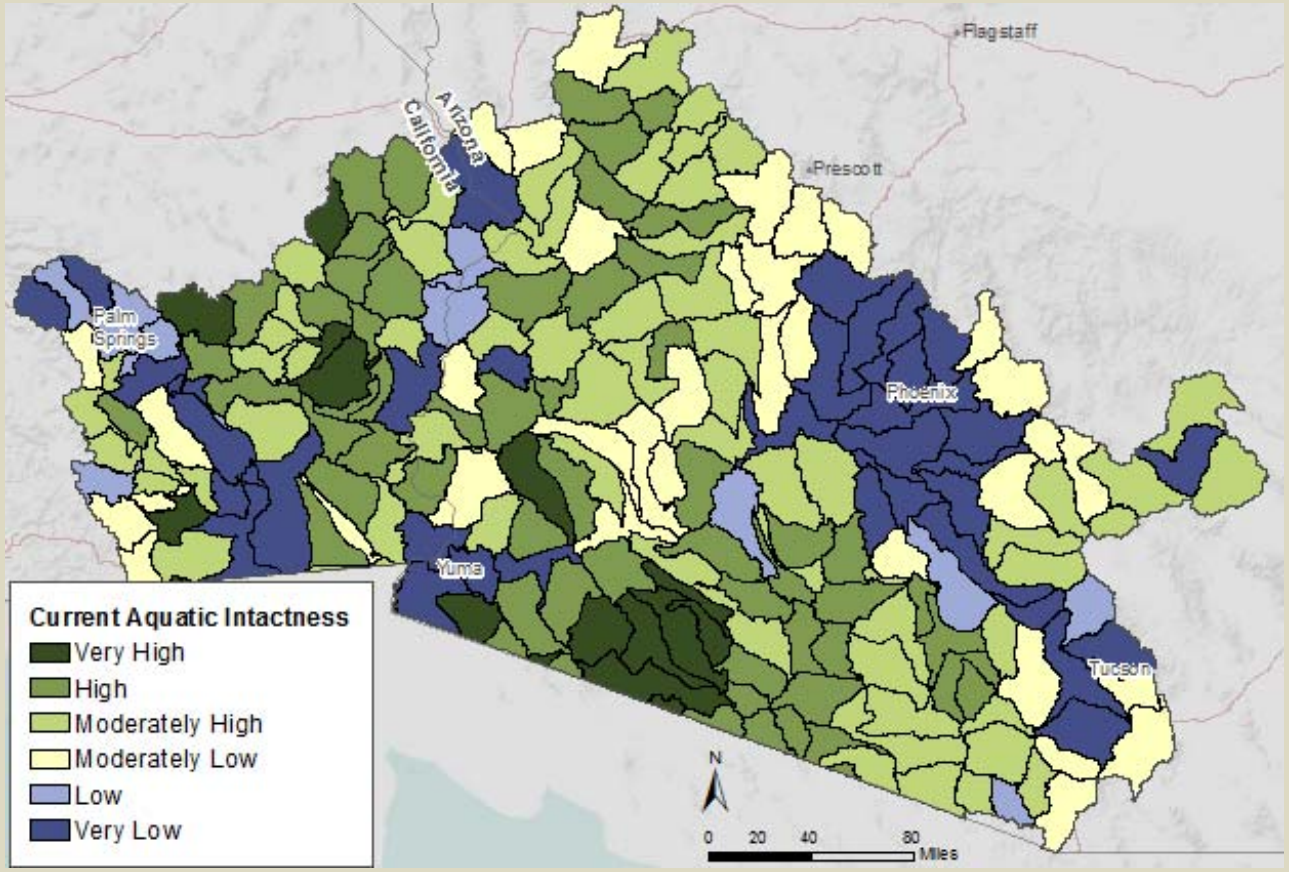


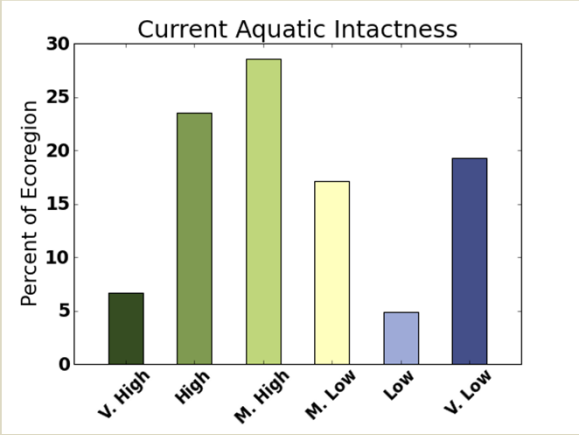
Current Aquatic Intactness



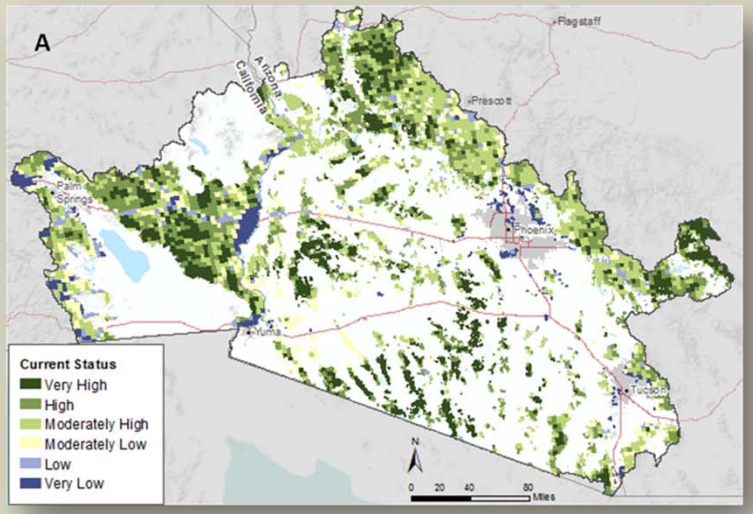

Flagstaff
Prescott
California
Arizona
Palm Springs
Phoenix
Yuma
Tucson
Current Terrestrial Landscape Intactness
Very High
High
Moderately High
Moderately Low
Low
Very Low
N
0 20 40 80
Miles

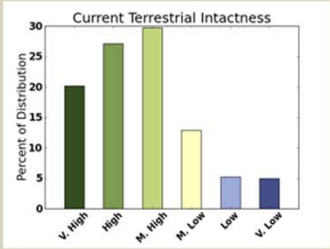

Current Terrestrial Intactness
Percent of Ecoregion
30
25
20
15
10
5
0
V. High
High
M. High
M. Low
Low
V. Low

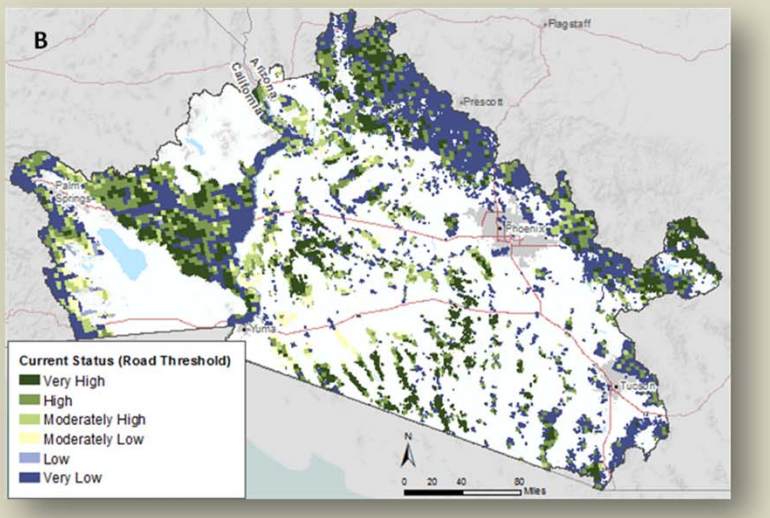

Flagstaff
Prescott
Arizona
California
Palm Springs
Phoenix
Yuma
Tucson
Current Aquatic Intactness
Very High
High
Moderately High
Moderately Low
Low
Very Low
N
0 20 40 80
Miles

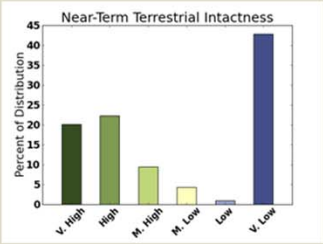

Current Aquatic Intactness
Percent of Ecoregion
0
5
10
15
20
25
30
V. High
High
M. High
M. Low
Low
V. Low

Mountain Lion

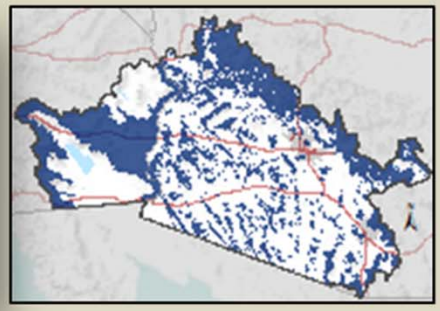


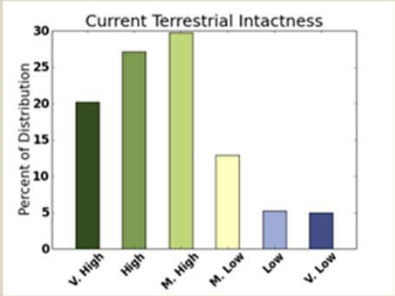




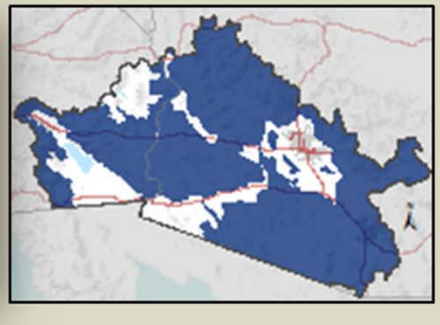


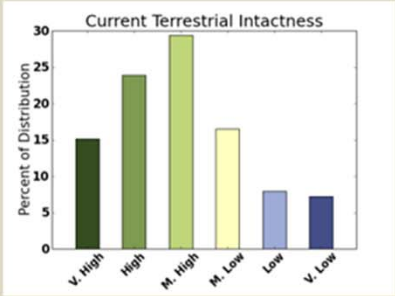
Mountain Lion



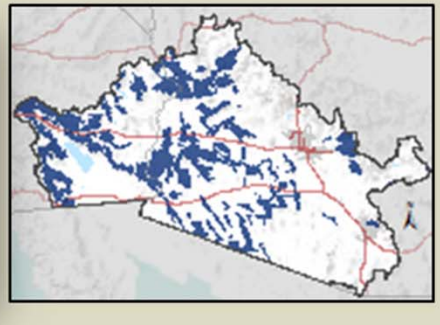


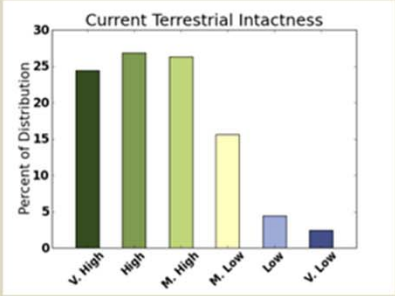
Mule Deer



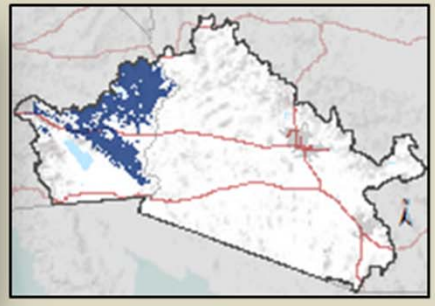


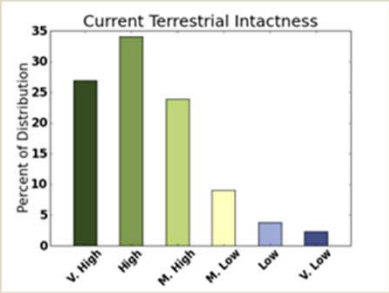
Desert Bighorn Sheep



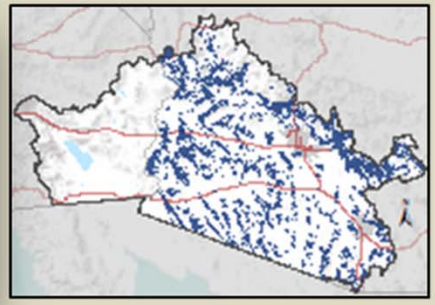


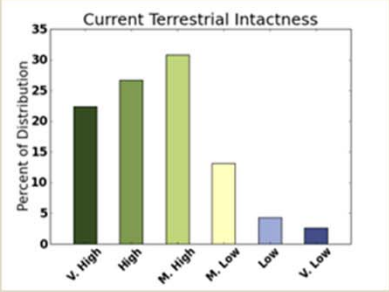
Desert Tortoise (agassizii)



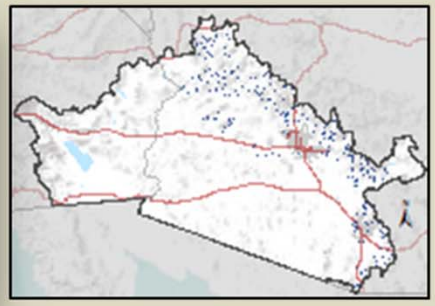


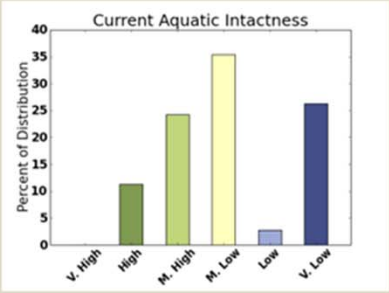
Desert Tortoise (morafkai)



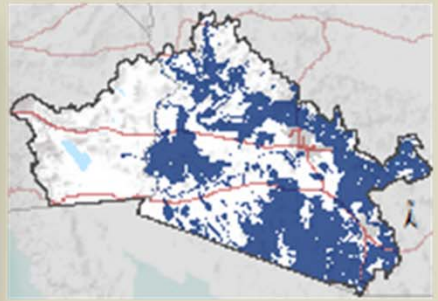


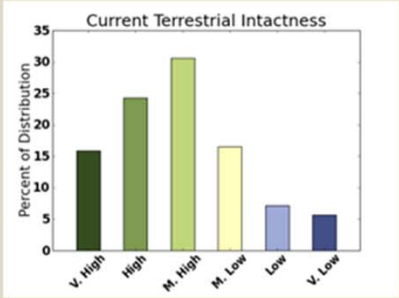
Lowland Leopard Frog



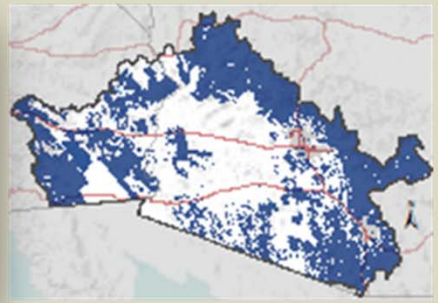


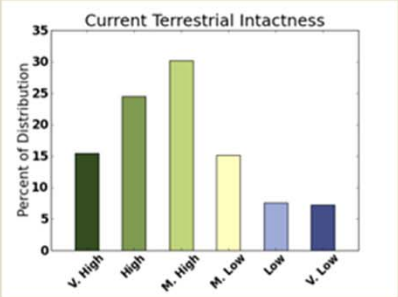
Lucy's Warbler



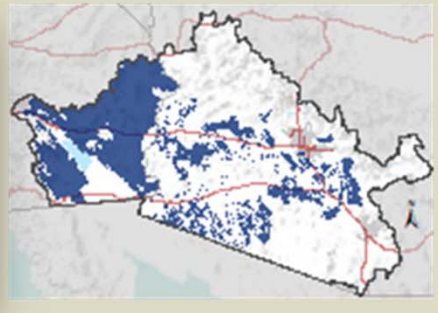


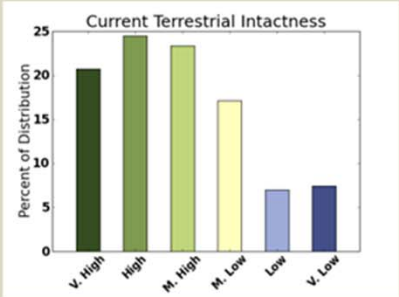
Golden Eagle



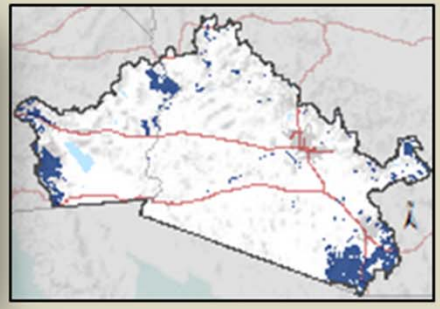


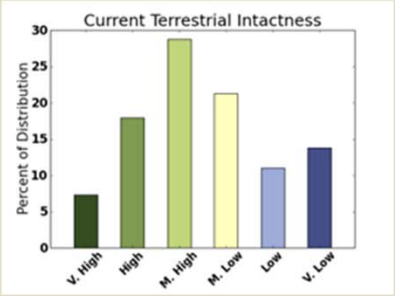
LeConte's Thrasher



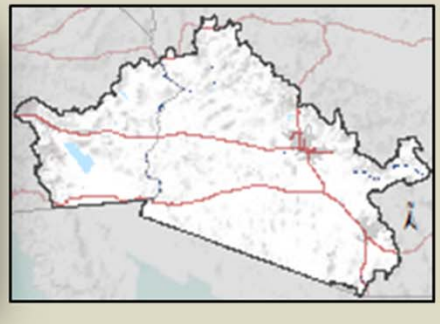


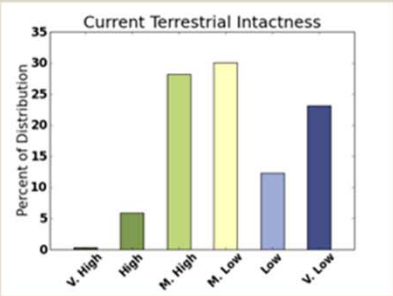
Bell's Vireo





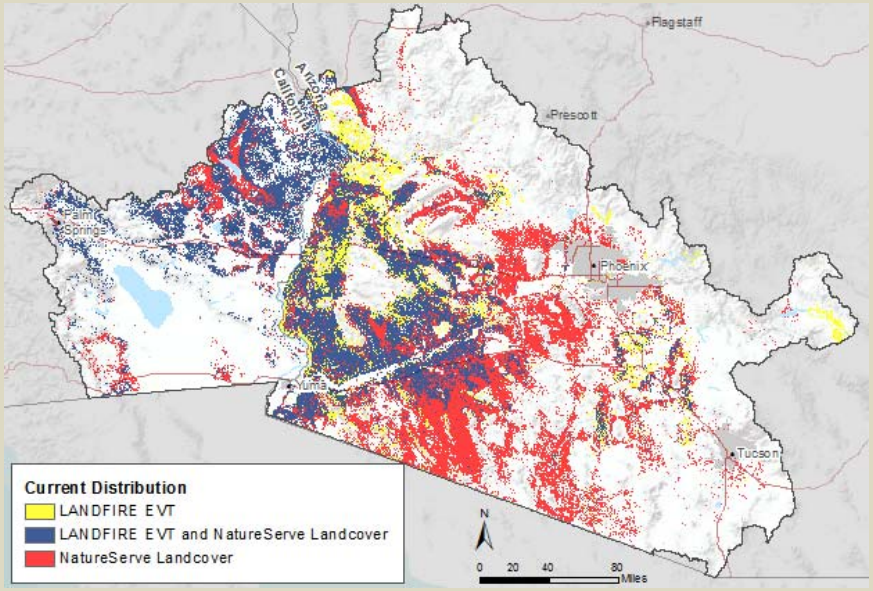
Southwest Willow Flycatcher



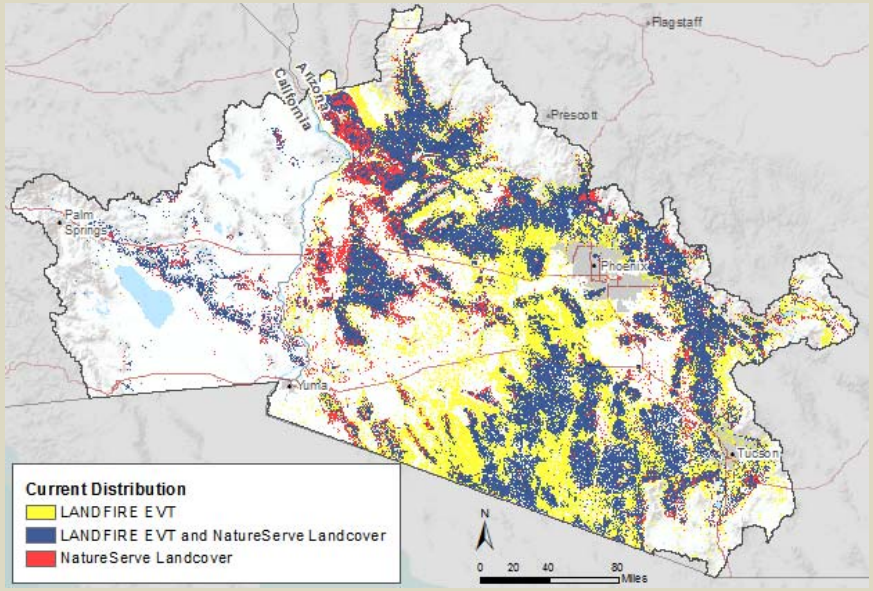


Distribution and Status
Vegetation Communities

Sonora-Mojave Creosotebush-White Bursage Desert Scrub



Sonoran Paloverde-Mixed Cacti Desert Scrub



Vegetation Community	NatureServe Only	LANDFIRE Only	Both	Percent Overlap
Sonora-Mojave Creosotebush-White Bursage Desert Scrub	5,361,364	1,417,474	4,823,357	**41.6**
Sonoran Paloverde-Mixed Cacti Desert Scrub	1,796,793	5,332,340	7,373,363	**50.84**
Riparian Vegetation	1,599,887			

Status of Vegetation Communities

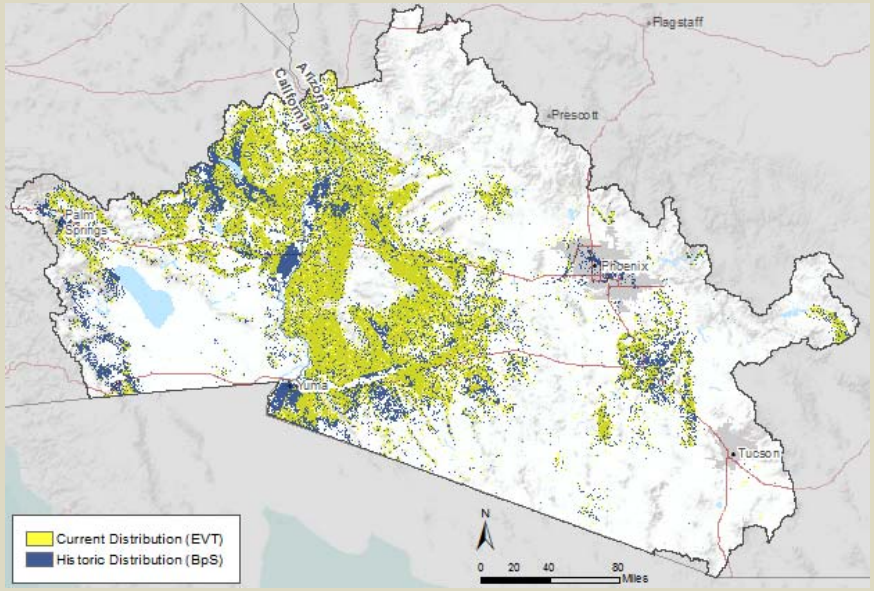
- Historic Conversion

- Recent Disturbance

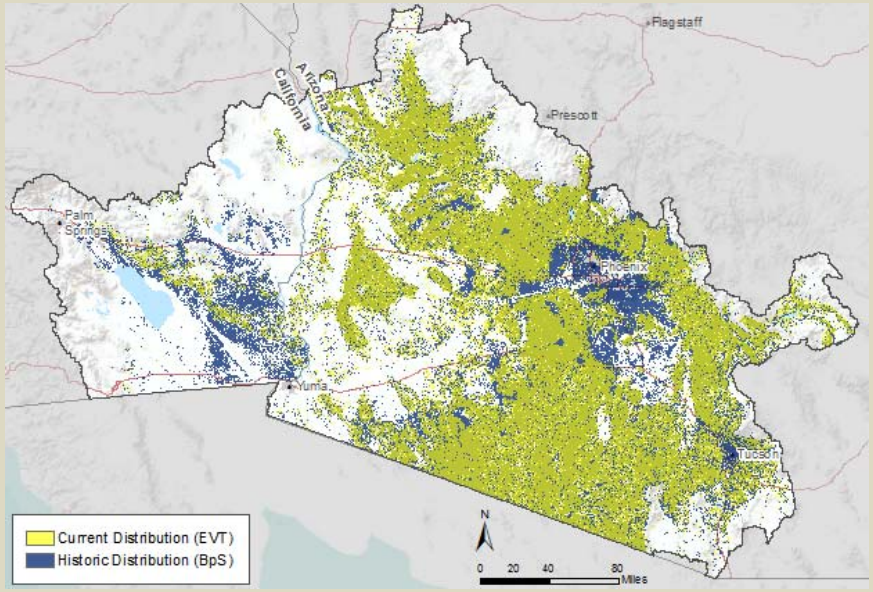
- Current Setting

EVT versus BsP

Sonora-Mojave Creosotebush-White Bursage Desert Scrub

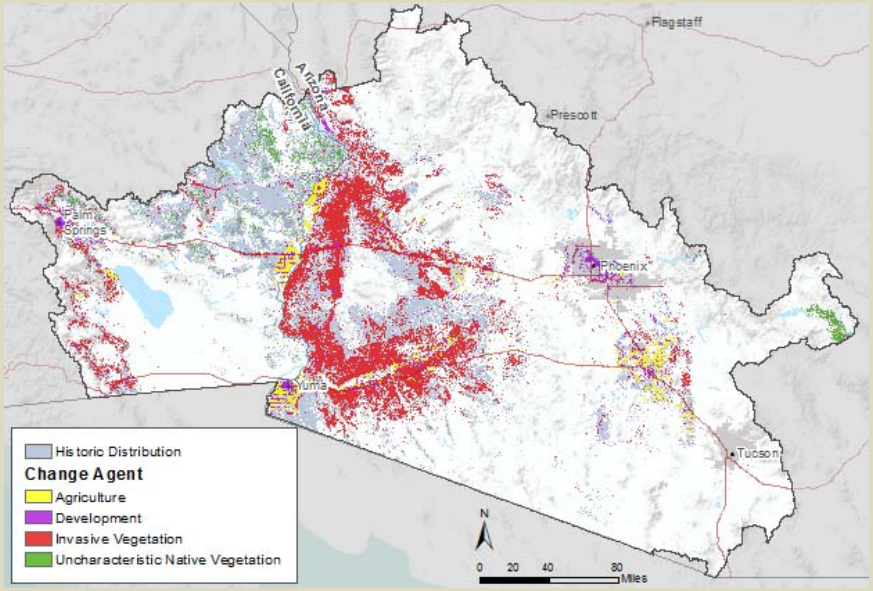


Sonoran Paloverde-Mixed Cacti Desert Scrub

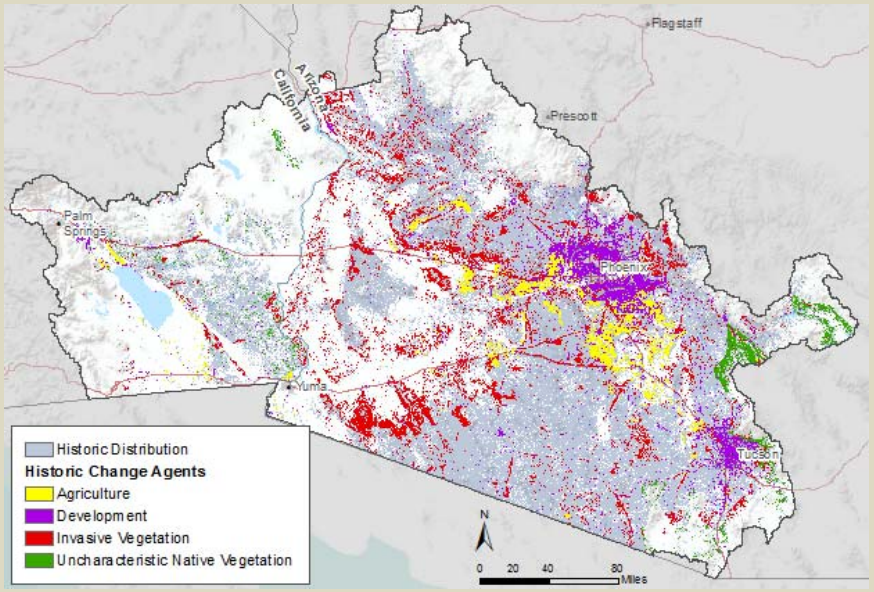


Historic Disturbance

Sonora-Mojave Creosotebush-White Bursage Desert Scrub

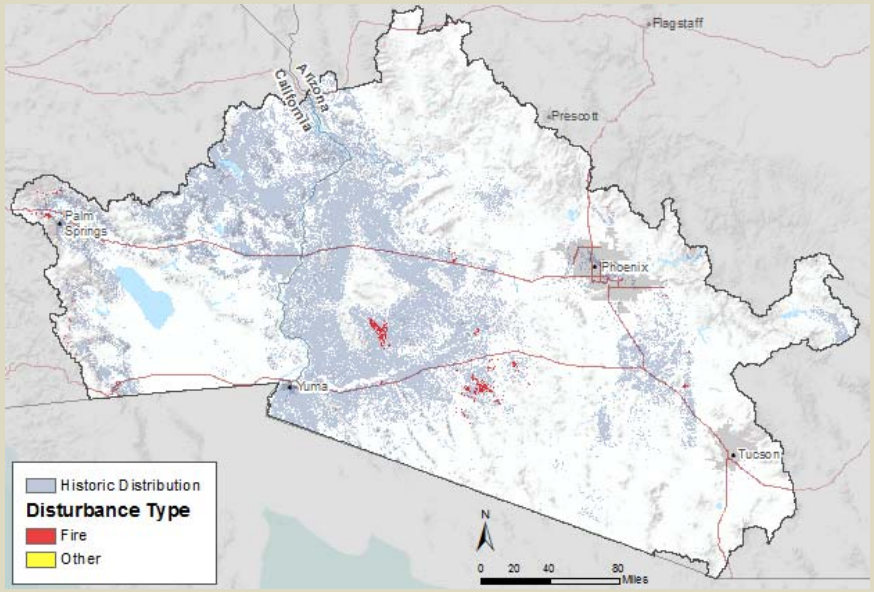


Sonoran Paloverde-Mixed Cacti Desert Scrub

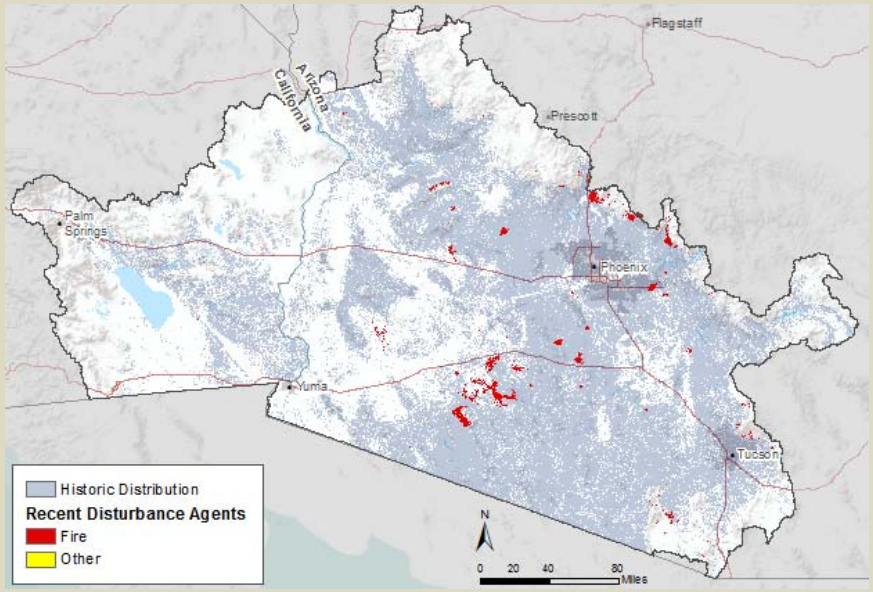


Recent Disturbance

Sonora-Mojave Creosotebush-White Bursage Desert Scrub



Sonoran Paloverde-Mixed Cacti Desert Scrub



Historic Disturbance

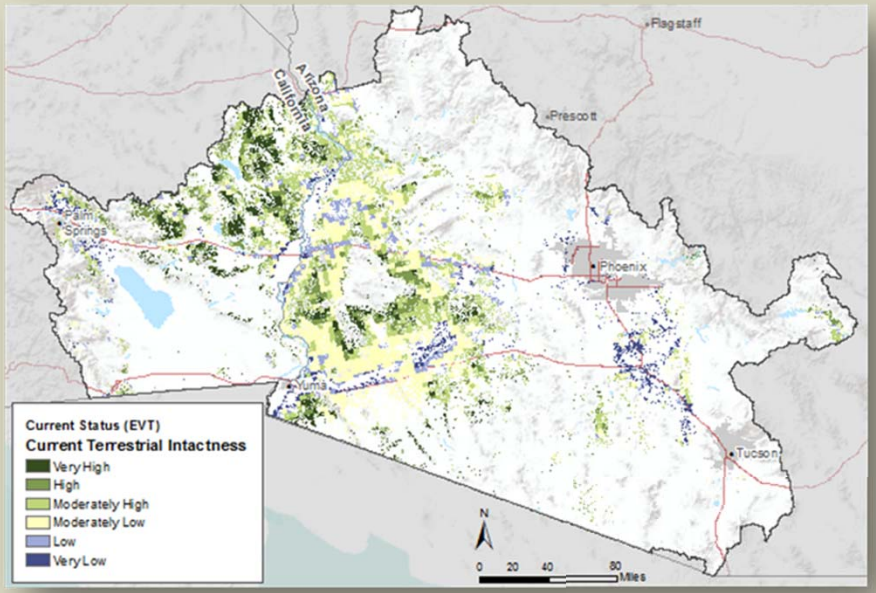
Vegetation Community	Total BpS Area	Urban & Roads	Agriculture	Invasives	Unchar Native Veg	Total Changed	Percent
Sonora-Mojave Creosotebush-White Bursage Desert Scrub	7,857,699	429,263	432,831	2,909,387	273,834	4,045,315	51.48%
Sonoran Paloverde-Mixed Cacti Desert Scrub	15,730,037	1,255,201	672,008	2,345,345	429,066	4,701,621	29.89%
Totals	**23,587,737**	**1,684,464**	**1,104,839**	**5,254,733**	**702,900**	**8,746,936**	**37.08%**

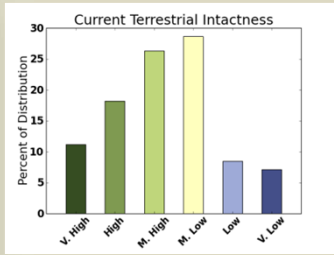
Recent Disturbance

Vegetation Community	Total BpS Area	Fire	Mechanical	Other	Total Disturbed	Percent
Sonora-Mojave Creosotebush-White Bursage Desert Scrub	7,857,699	85,434	0	80	85,514	1.09%
Sonoran Paloverde-Mixed Cacti Desert Scrub	15,730,037	212,197	0	18	212,216	1.35%
Totals	**23,587,737**	**297,631**	**0**	**98**	**297,730**	1.26%

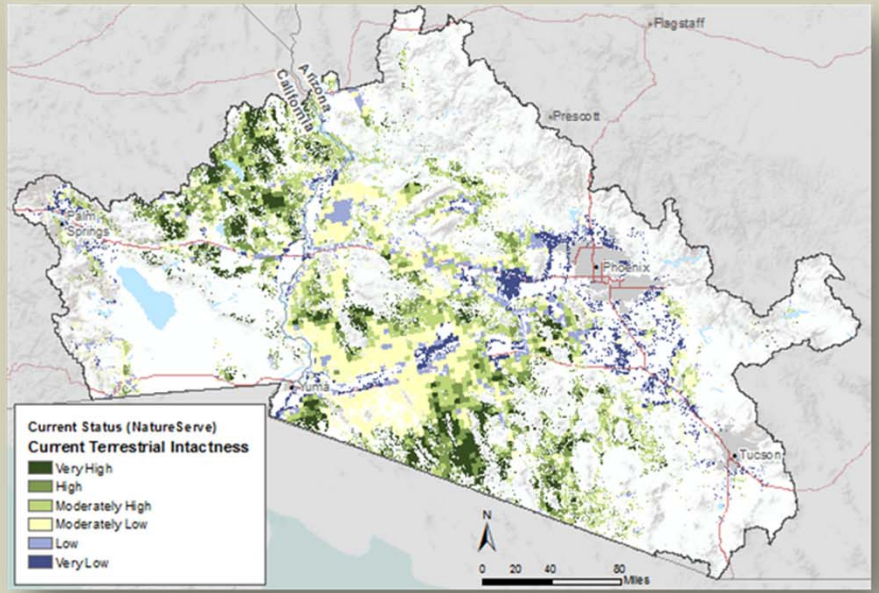
Current Setting

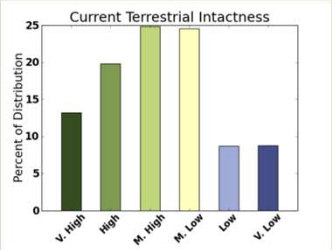
Sonora-Mojave Creosotebush-White Bursage Desert Scrub - LANDFIRE





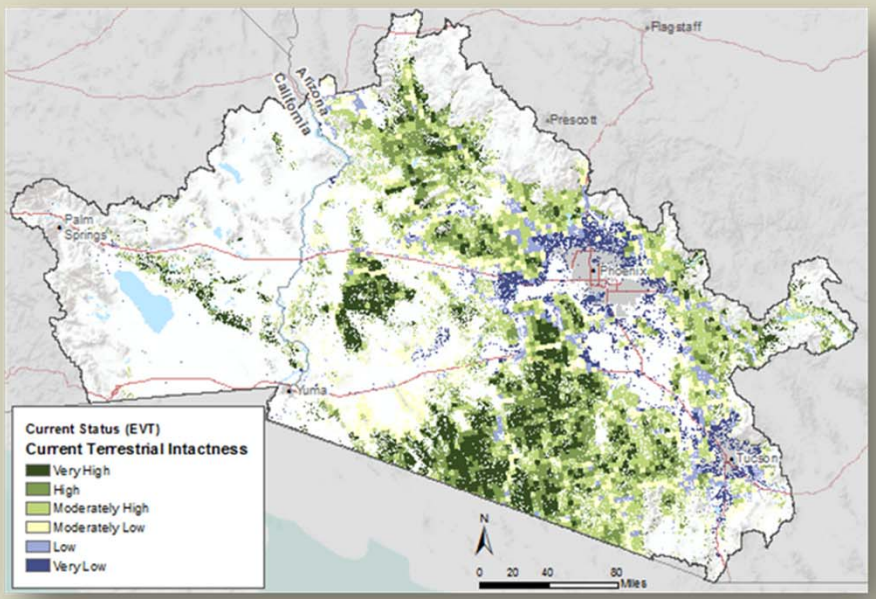
Sonora-Mojave Creosotebush-White Bursage Desert Scrub - NatureServe

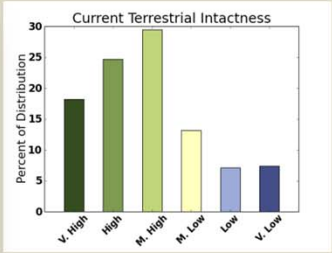




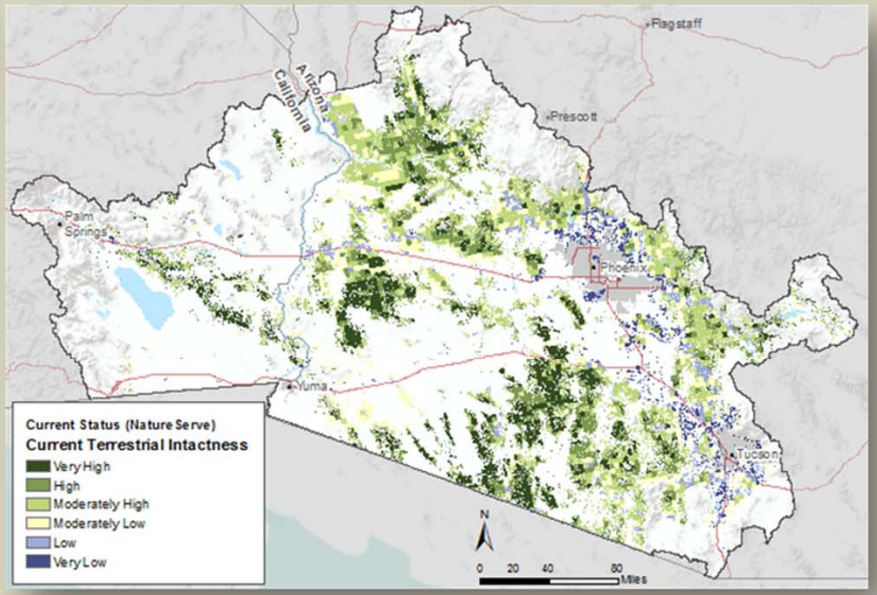
Current Setting

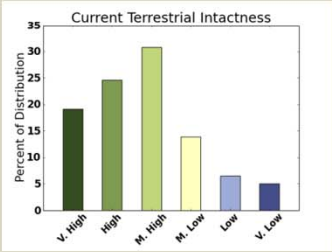
Sonoran Paloverde-Mixed Cacti Desert Scrub - LANDFIRE



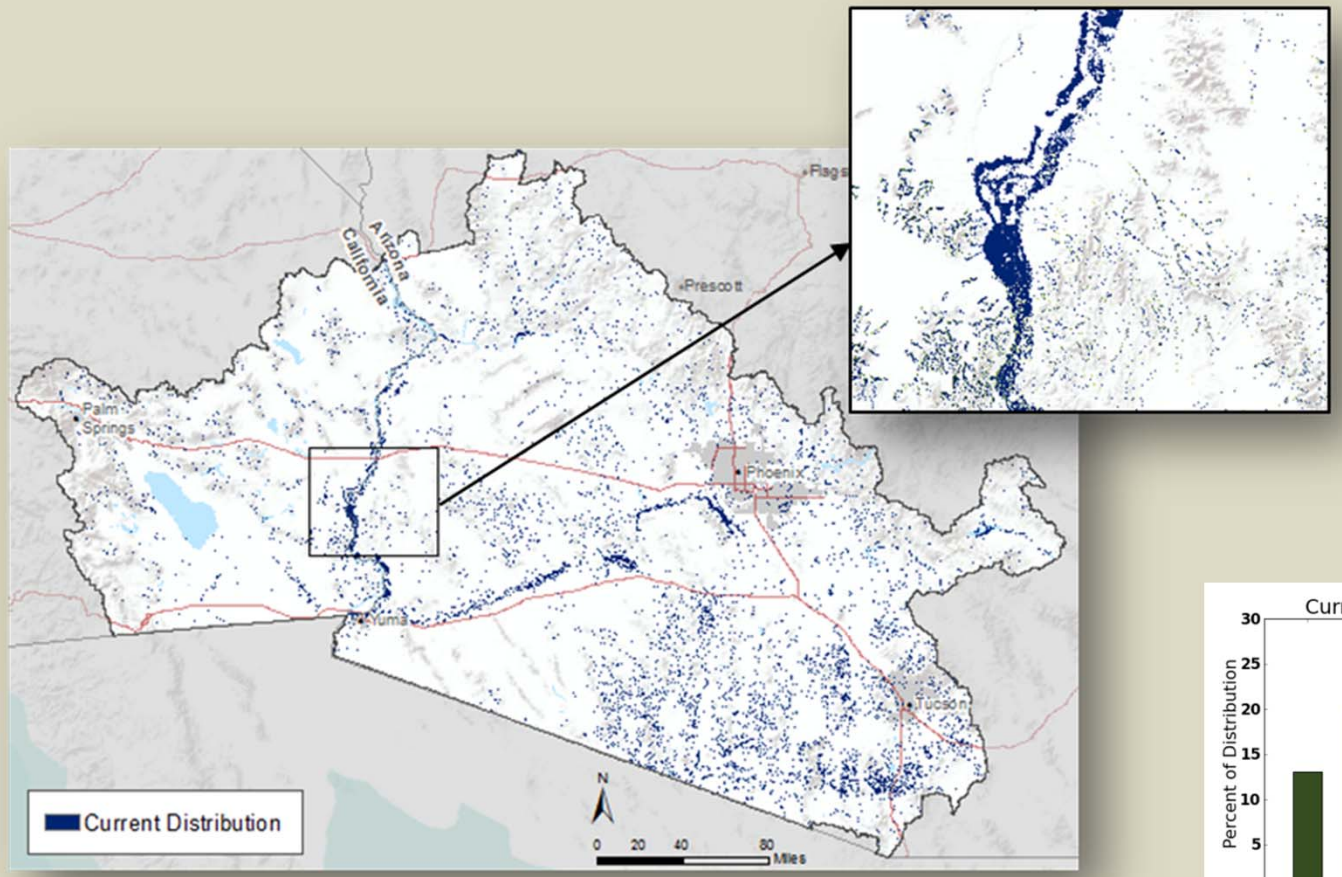


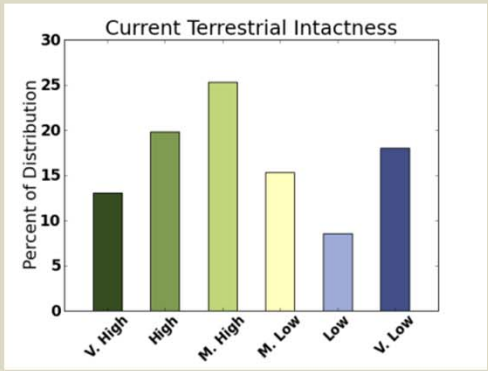
Sonoran Paloverde-Mixed Cacti Desert Scrub - NatureServe



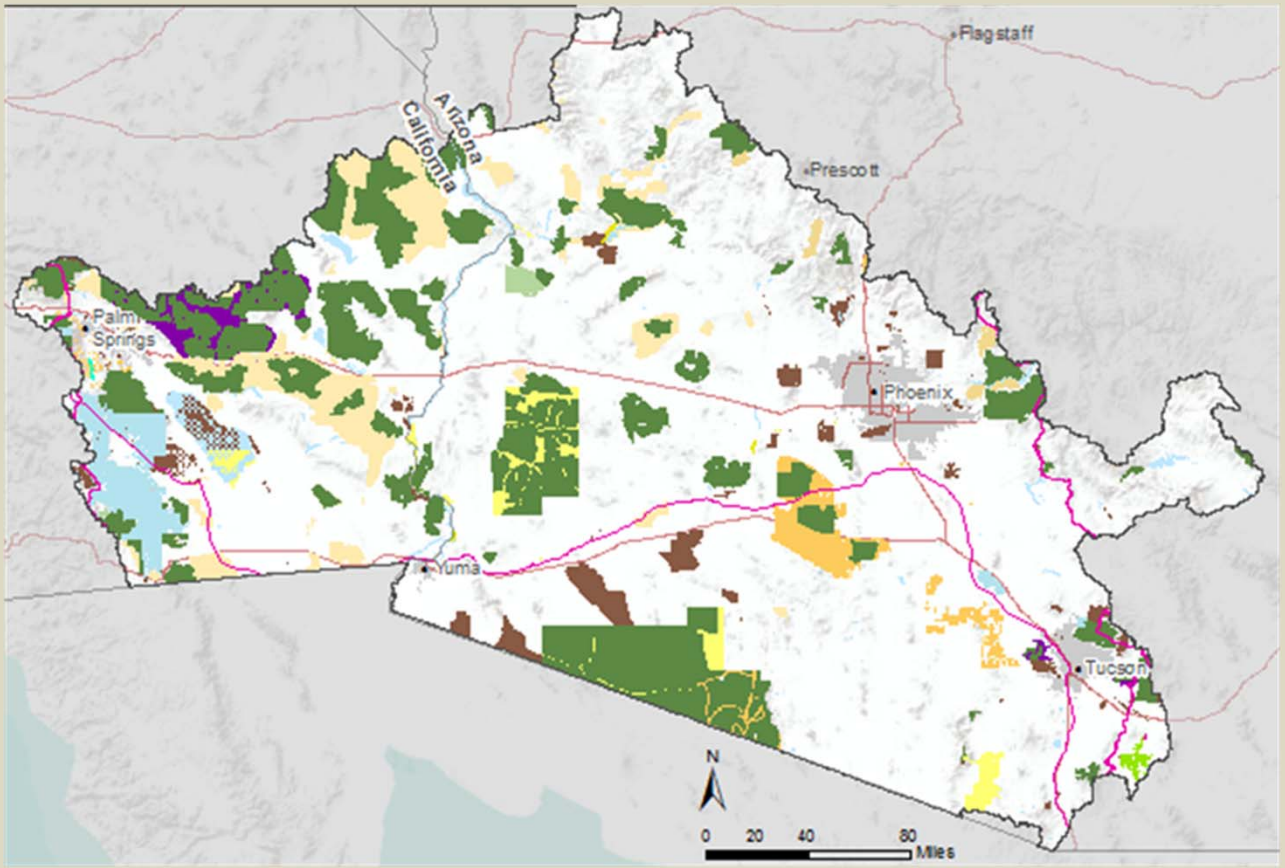


Riparian Vegetation





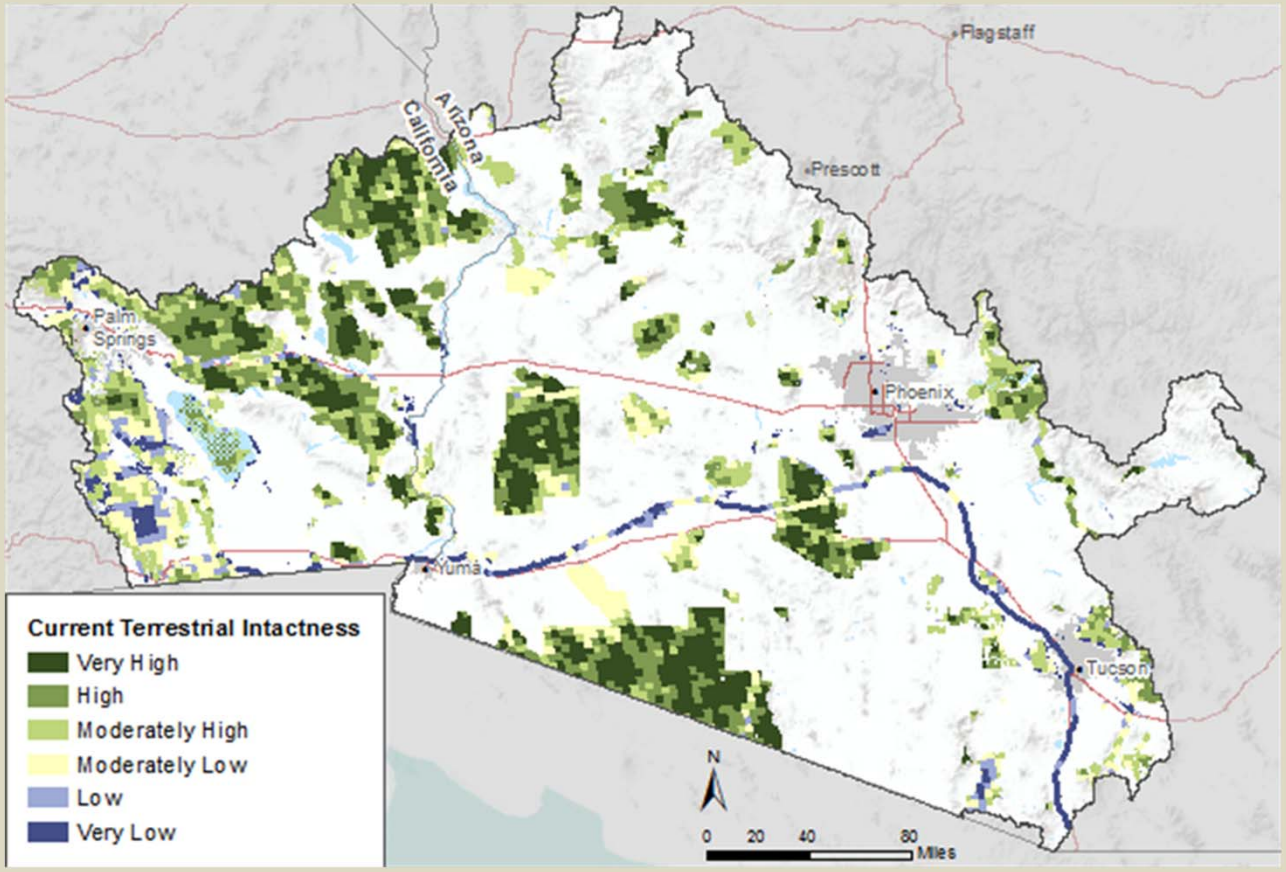
Designated Lands

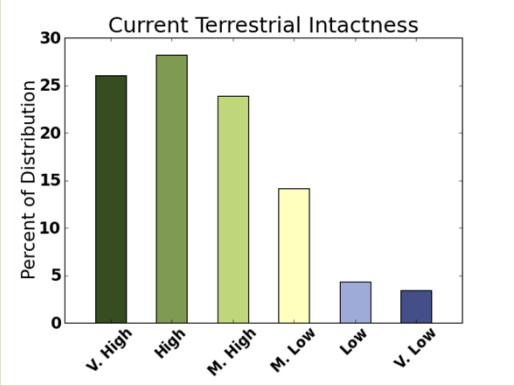


Designation

- Wilderness Area
- Wilderness Study Area
- National Park
- National Monument
- National Conservation Area
- National Recreation Area
- National Wildlife Refuge
- Area of Critical Environmental Concern
- Special Management Area
- State Park
- State Wildlife Management Area
- Roadless Area
- Other Protected Lands
- National Historic and Scenic Trail
- Wild and Scenic River

Designated Lands





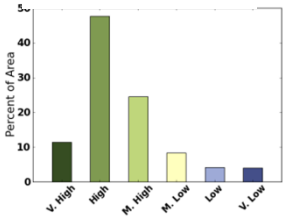
Designated Lands

Designation Category	Very High	High	Moderately High	Moderately Low	Low	Very Low	Total Area (acres)
Wilderness Area	1,812,561	1,632,927	1,011,143	451,464	55,862	21,933	4,985,891
Wilderness Study Area	0	0	6,620	55,984	2,525	2,272	67,401
National Park	19,819	83,040	42,873	14,441	7,178	6,979	174,330
National Monument	127,785	148,652	158,627	68,922	24,265	6,305	534,556
National Conservation Area	0	6,779	21,819	7,638	95	0	36,331
National Wildlife Refuge	91,295	95,602	51,145	61,499	39,637	31,834	371,011
Area of Critical Conservation Concern	257,951	409,293	503,740	174,291	95,838	41,669	1,482,783
State Park	1,151	35,434	152,845	212,951	126,418	105,968	634,768
State Wildlife Management Area	1,202	288	4,250	3,126	4	4,819	13,689
Roadless Area	11,564	32,957	65,350	5,908	2,526	0	118,306
Other Protected Lands	71,122	153,511	177,174	243,082	43,660	97,114	785,663
Totals	2,394,451	2,598,484	2,195,588	1,299,307	398,008	318,893	9,204,730

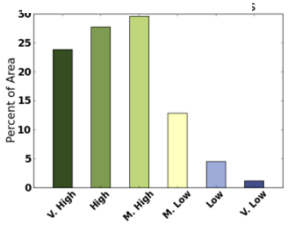
Designation Category	Very High	High	Moderately High	Moderately Low	Low	Very Low	Total Area (miles)
National Historic and Scenic Trail	28	97	179	160	69	282	815
Wild and Scenic River	0	1	6	0	2	0	9
Totals	28	99	185	160	71	282	823

Designated Lands

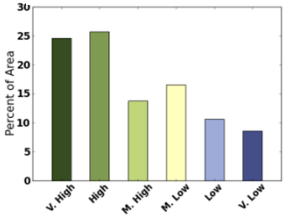
National Parks



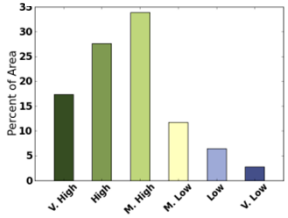
National Monument



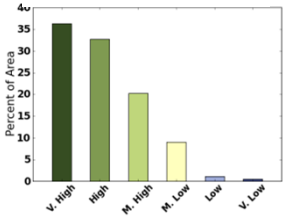
National Wildlife Refuge



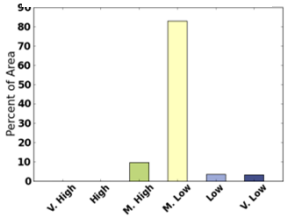
Areas of Critical Environmental Concern



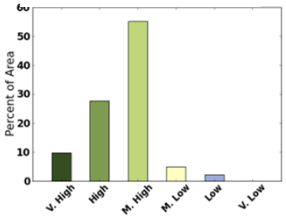
Wilderness Areas



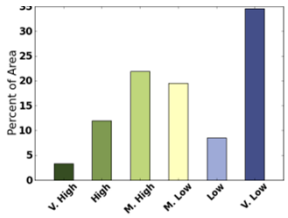
Wilderness Study Areas



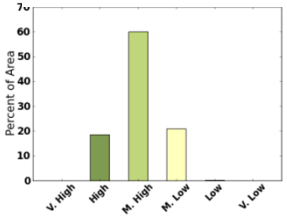
Roadless Areas



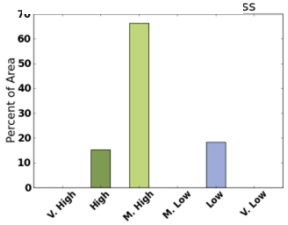
National Historic and Scenic Trails



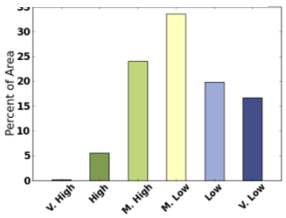
National Conservation Area



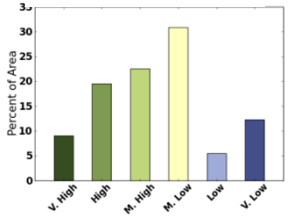
Wild & Scenic Rivers



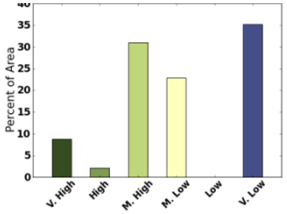
State Parks



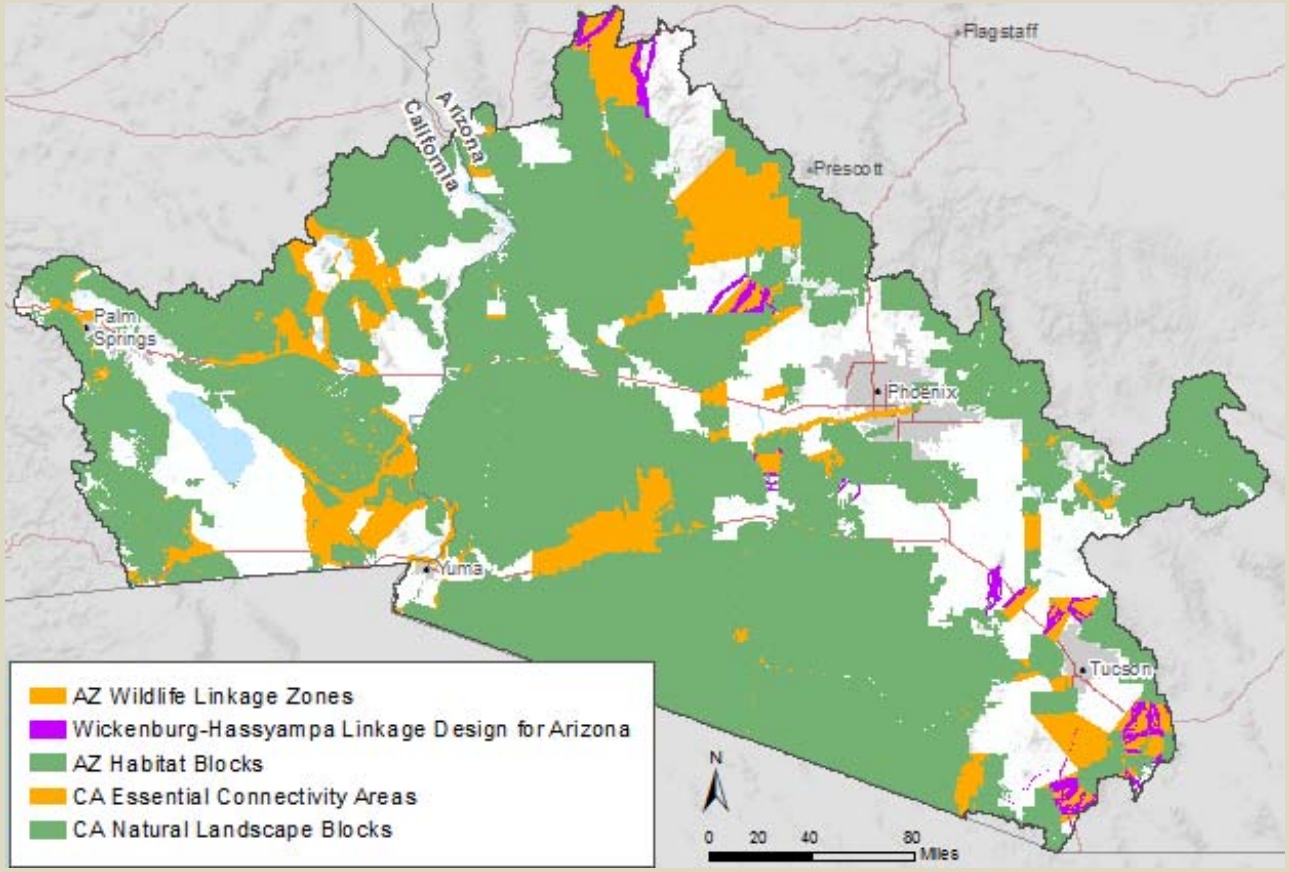
Other Protected Lands



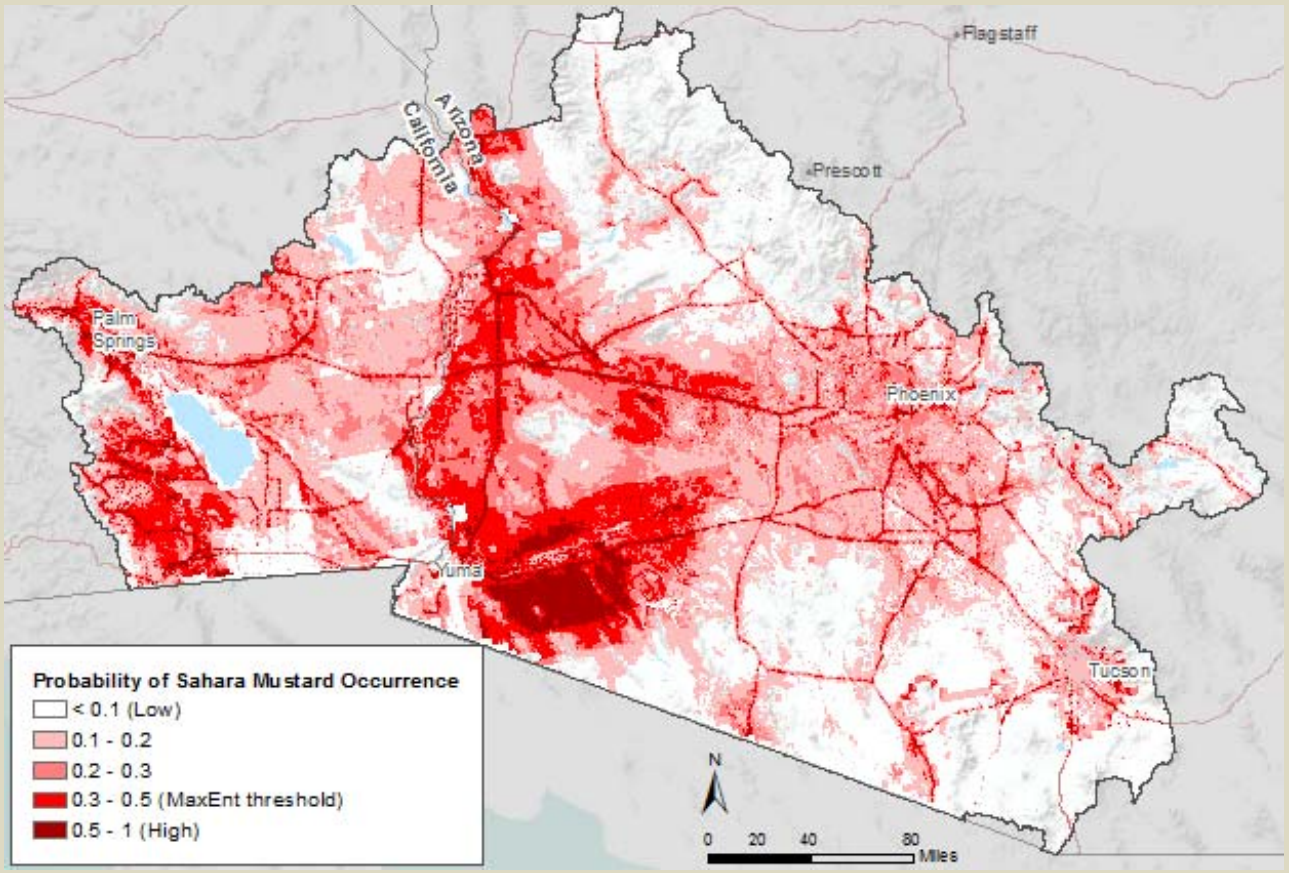
State Wildlife Management Areas



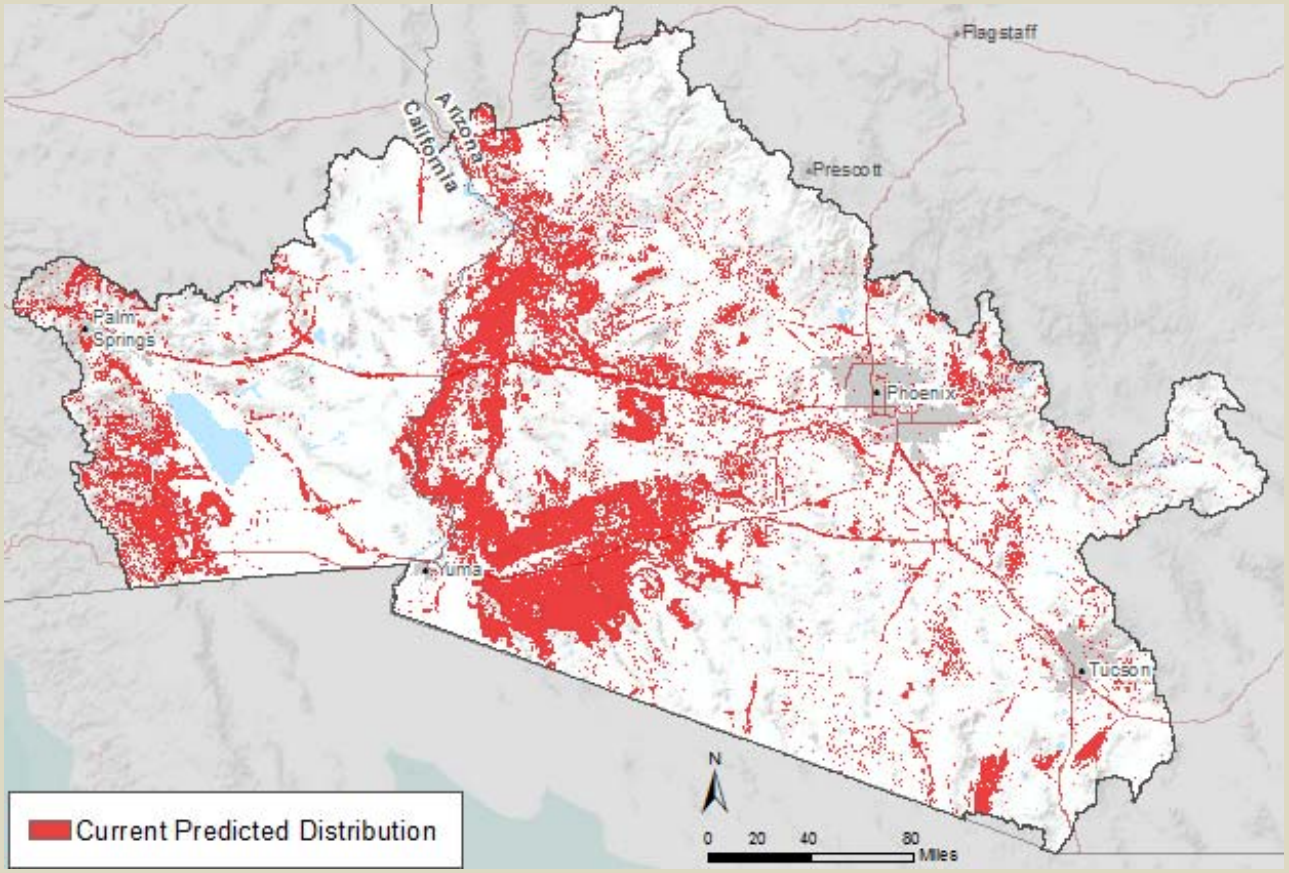
Terrestrial Connectivity



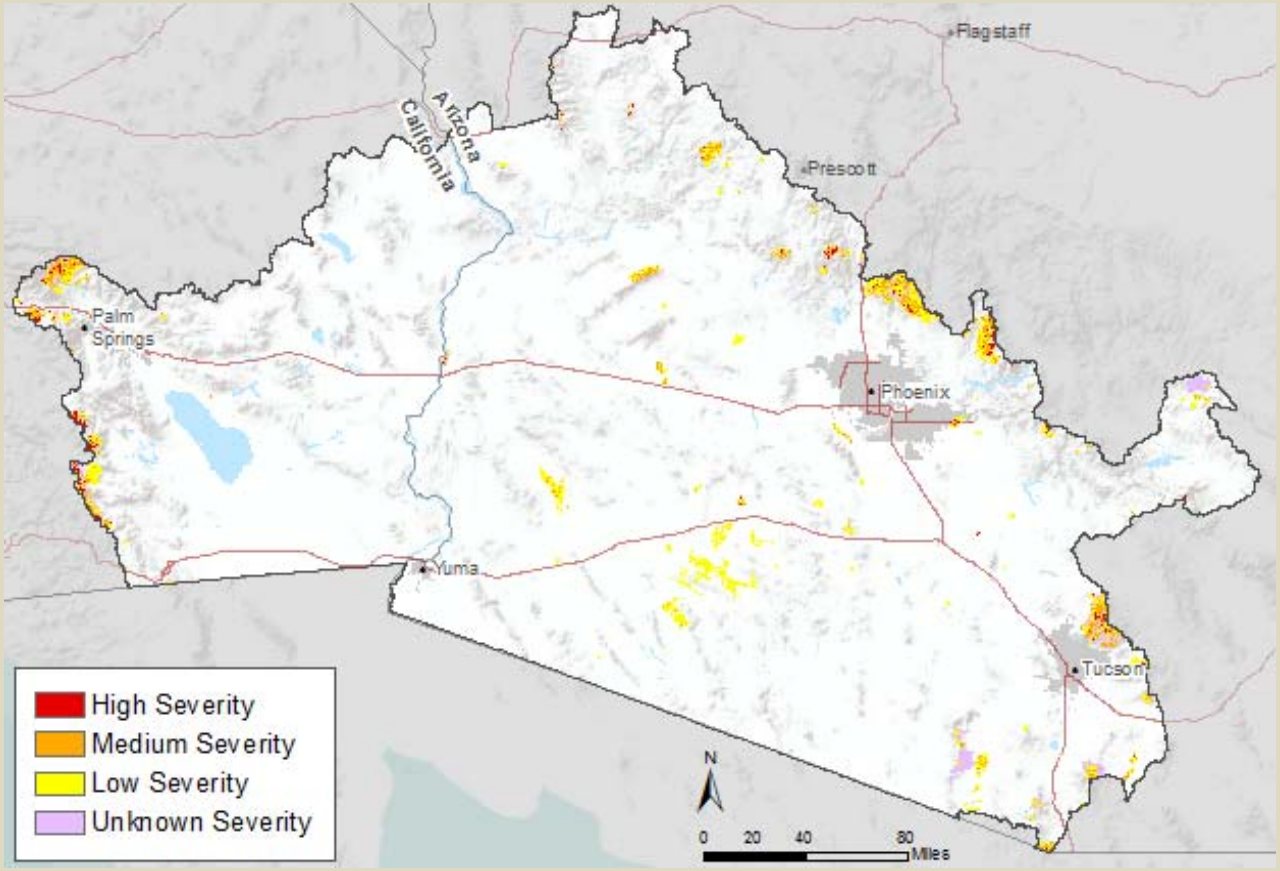
Change Agent - Current Invasives



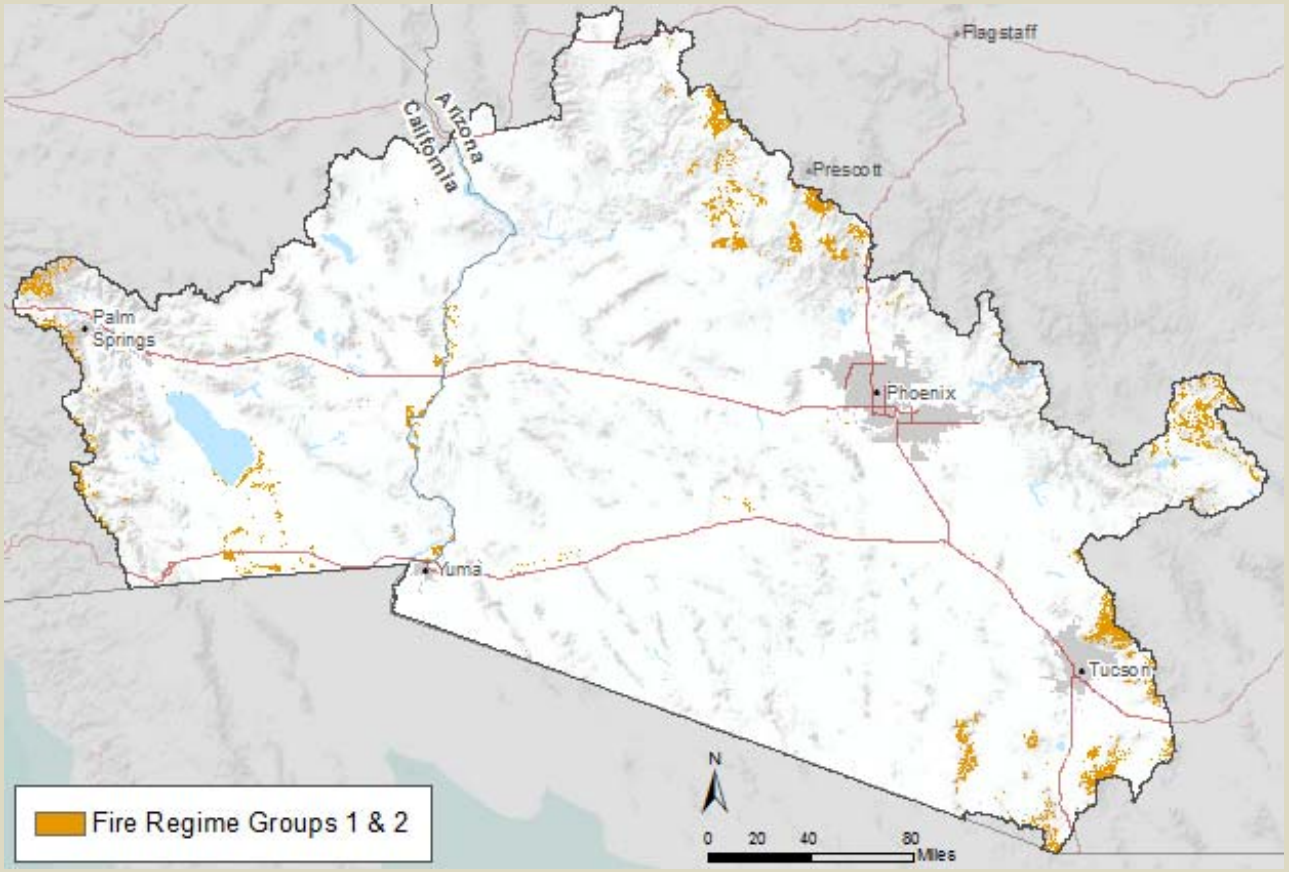
Change Agent - Current Invasives



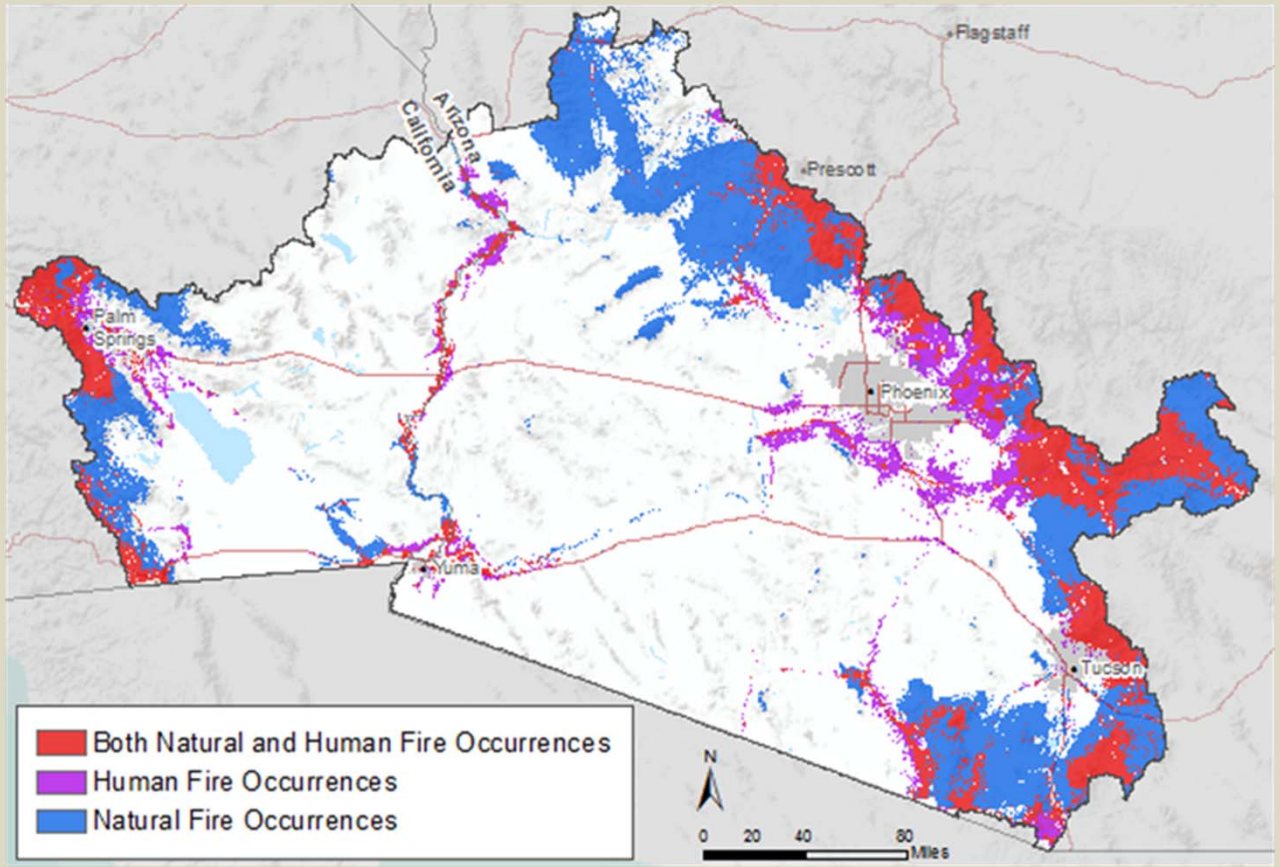
Change Agent – Fire



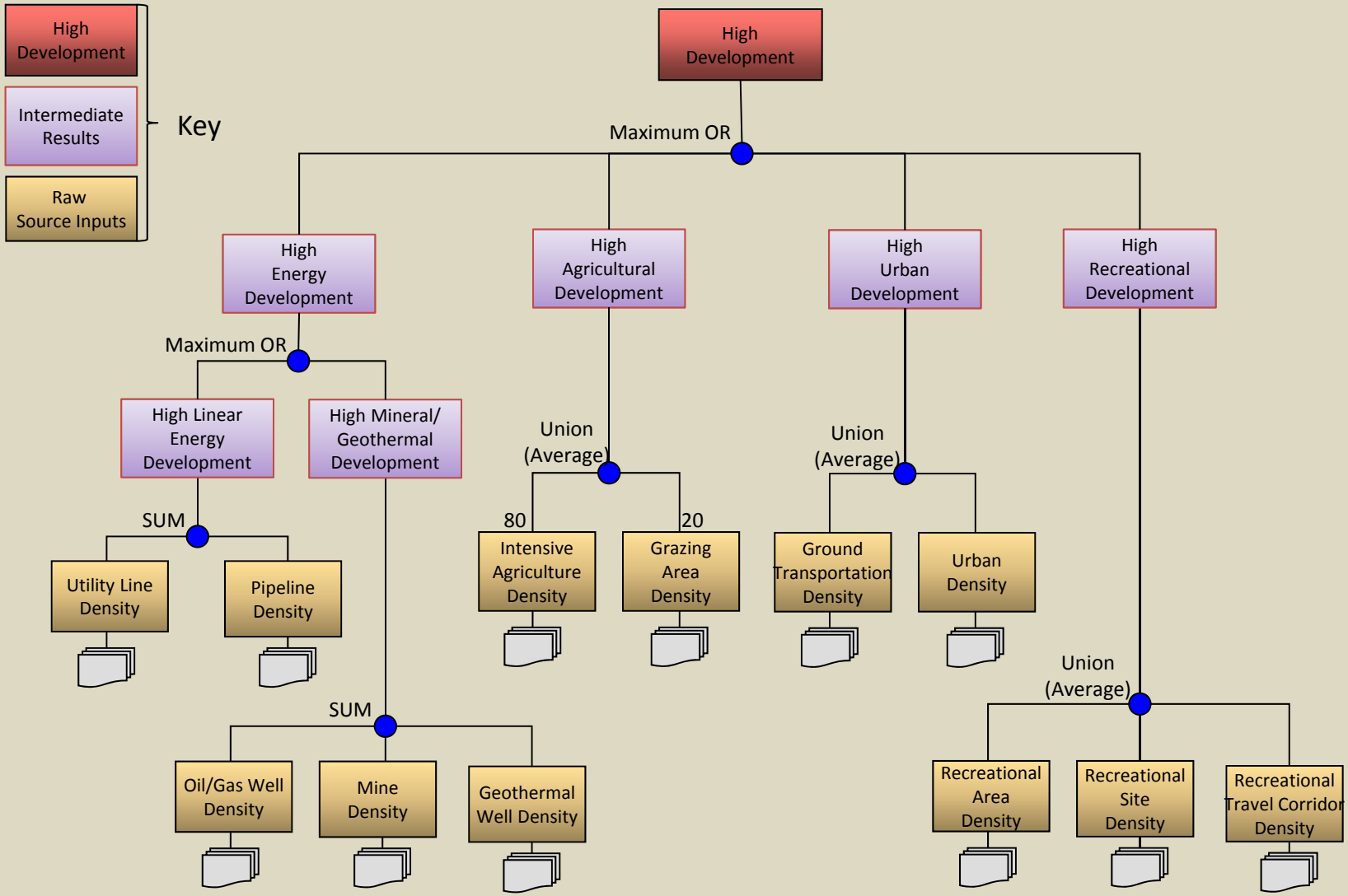
Change Agent – Fire



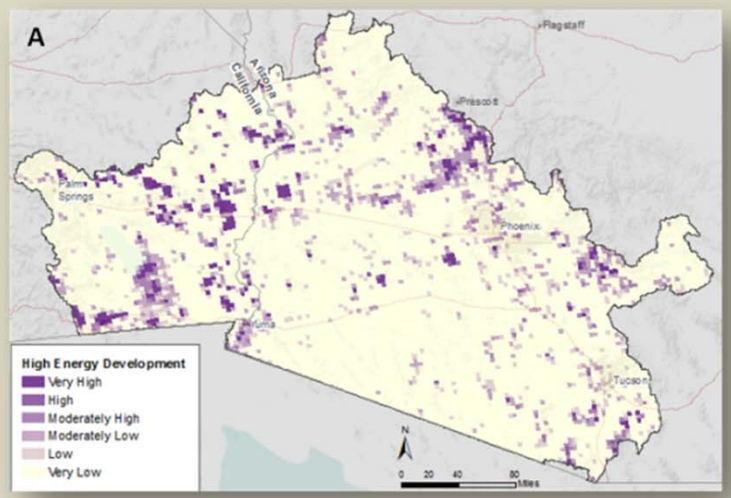
Change Agents - Fire

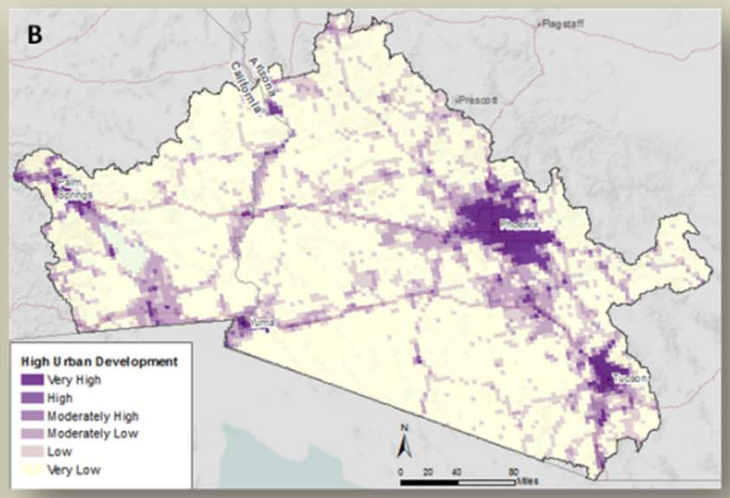


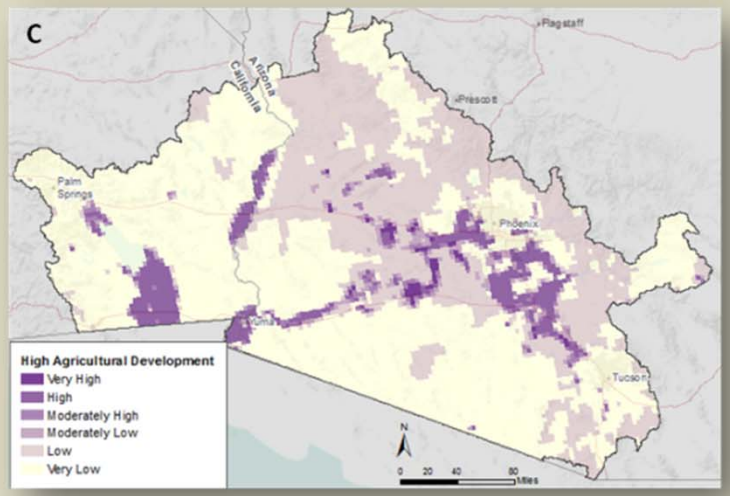
Change Agent – Current Development

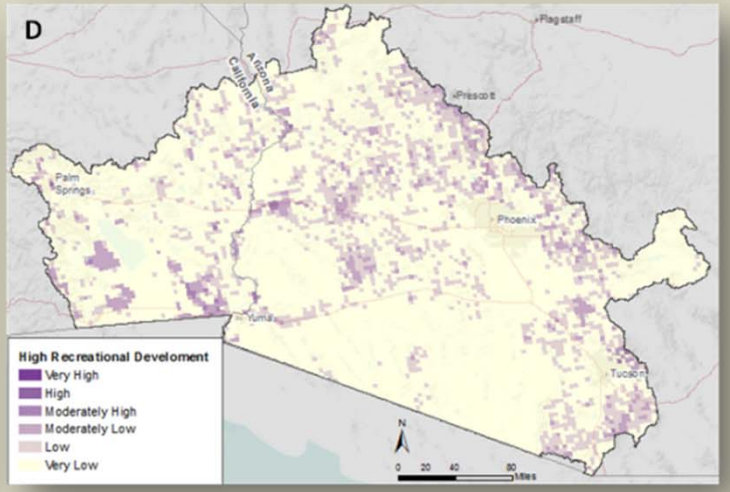
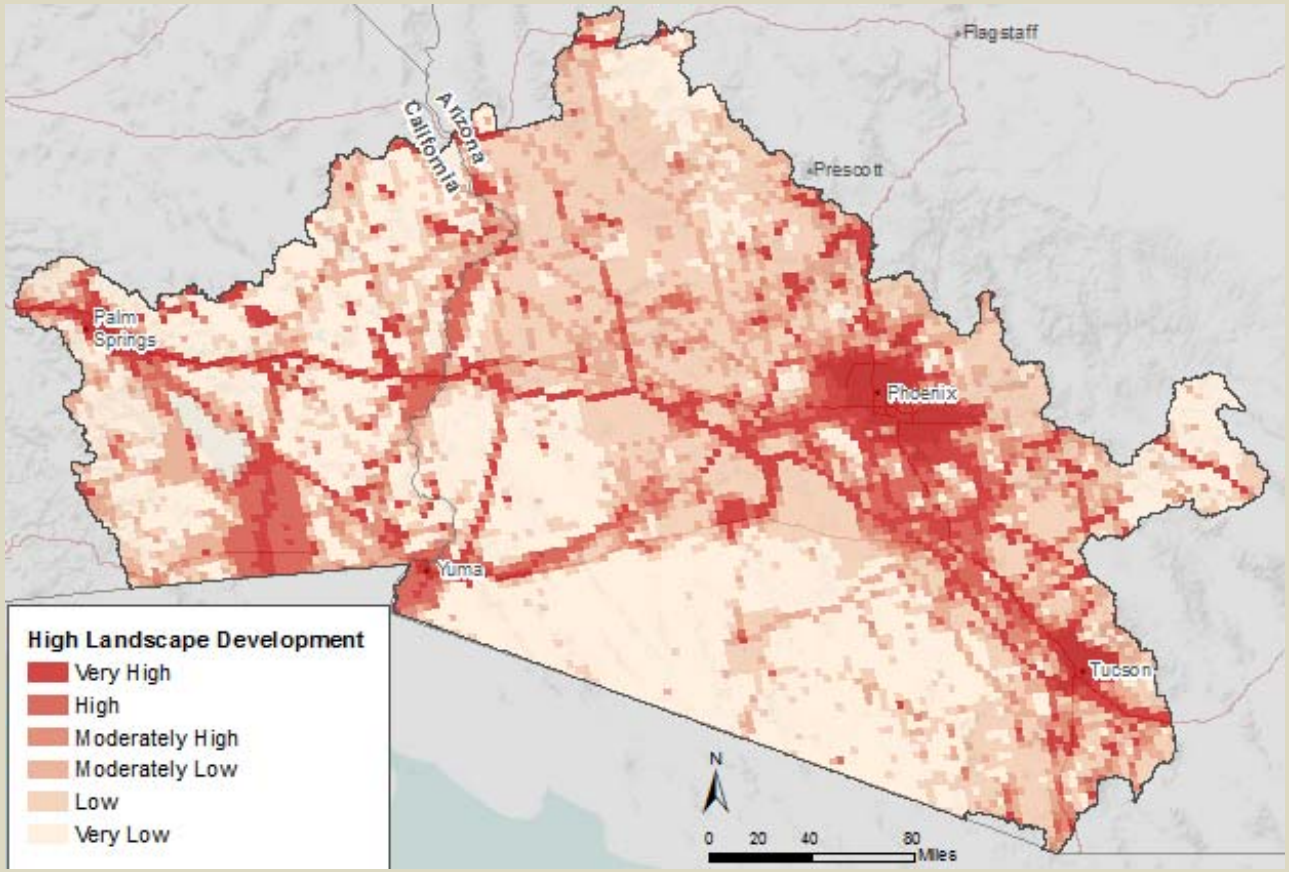


Change Agent – Current Development









Change Agent – Current Development